Analysis of Heavy-Duty Vehicle Sales Impacts Due to New Regulation:

Response to Reviewers Comments

EPA United States Environmental Protection Agency

Analysis of Heavy-Duty Vehicle Sales Impacts Due to New Regulation:

Response to Reviewers Comments

Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

Prepared for EPA by
ERG, Eastern Research Group, Inc.
EPA Contract No. EP-C-17-011
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and

RTI International
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NOTICE

This technical report does not necessarily represent final EPA decisions or positions. It is intended to present technical analysis of issues using data that are currently available. The purpose in the release of such reports is to facilitate the exchange of technical information and to inform the public of technical developments.

EPA United States Environmental Protection Agency

EPA-420-R-21-014
May 2021

March 2021

MEMORANDUM

SUBJECT: Peer Review for ERG Report, "Analysis of Heavy-Duty Vehicle Sales Impacts Due to New Regulation"

In August 2020, EPA contracted with RTI International, who enlisted EnDyna as a subcontractor (RTI/EnDyna), to conduct a peer review of a study conducted by ERG and its subcontractor EERA (ERG/EERA). The draft study, titled "Analysis of Heavy-Duty Vehicle Sales Impacts Due to New Regulation," estimated the effects of EPA standards for heavy-duty vehicles on sales of those vehicles, including whether the standards elicited increased sales in advance of the standards (pre-buy) and reduced sales after the standards came into effect (low-buy).

The peer reviewers selected by RTI/EnDyna were Drs. José Holguín-Veras of Rensselaer Polytechnic Institute, Amelia Regan of the University of California at Irvine, Yan (Joann) Zhou of Argonne National Laboratory, and Yichén (Christy) Zhōu of Clemson University. EPA would like to extend its appreciation to all four reviewers for their efforts in evaluating this survey. The reviewers brought useful and distinctive views in response to the charge questions.

The first section of this document contains the final ERG/EERA report responding to the peer reviewers' comments. The second section provides the peer review report conducted by RTI/EnDyna. It documents the peer review process, provides both a summary of the peer review comments and the detailed responses, the peer reviewers' curriculum vitae, the agenda from a teleconference, and the form EnDyna used to evaluate potential conflicts of interest.

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Analysis of Heavy-Duty Vehicle Sales Impacts Due to New Regulation: Response to Reviewer Comments

Comments received are categorized into minor, moderate, and major. Minor comments do not affect the outcomes of the report and may be addressed with straightforward adjustments to the text. Moderate comments do not affect the outcomes of the report, but require more significant adjustments to the text, or effort to update tables and figures. Major comments may affect the outcomes of the report and may require extensive modifications to the text, tables, and figures, and may include adjustments to model specification

February 25, 2021

1 Minor

Reviewer	Section	Comment	Response
Dr. Yan Zhou	Ex. Sum. and Conclusion	suggest changing the "abstract" to "Executive Summary" and move some of the contents from the "Conclusions" to "Summary". For people who do not have time to read the 80-page report, they can still comprehend a full picture of the data and methodologies used, as well as the key take-ways from this study.	Abstract changed to "Executive Summary" and key sections from the conclusions were copied to the executive summary
Dr. Yan Zhou	1	suggest clarifying in the "Introduction" and "Summary" that although the HDV regulation covers from class 2b to class 8, this study focus on class 6-8 due to data limitations.	Suggestion incorporated
Dr. Yan Zhou	3	In the beginning of Section 3 Data and Methodology, I would suggest adding a table to show all the data considered in the analysis and modeling. • Variable • Models (in which data was used) • Unit • Source • Notes	Table added to top level of Section 3: Data and Methodology
Dr. Yan Zhou	2.8	Table 3 and Section 4.7: More description about how these costs were estimated and used in this analysis would be appreciated.	Text has been added discussing these regulations and associated costs.
Dr. Yan Zhou	3.1.1	Page 38 Section 3.1.1: Please cite the reference for the vehicle sales in the content, not just on the figure.	Citation added
Dr. Yan Zhou	4.2	Page 55 Section 4.2: I am confused about what exactly is the dependent variable? The Class 7 or 8 sales, or the changes in the monthly sales?	Changed dependent variable to Sales_i,t, where i is class, and t is month of year

Dr. Yan Zhou	4.4.2	Page 60-61: Was the effect due to recession considered when analyzing the impact of 2007 regulations? The recession was mentioned earlier when discussing the sales trend. However, it was not clear whether that was controlled in the analysis.	Text has been added to section 4.4.2 on p61 discussing how the models control for recession periods, by controlling for change in GDP, and how the results indicate a diminishing low-buy effect (and lower statistical power) approaching the recession
Dr. Yan Zhou	3.1.4	Page 44/Figure 8: Could you add an example to show how to read the chart, such as the "regime shifts in the PPI-Trucks corresponding to the 2007 and 2010 enforcement periods"?	Added discussion of the changepoint algorithm and graph interpretation to section 3.1.4.
Dr. Yan Zhou	2.3.4	Page 11/17: Why would buyers move up in vehicle class if higher class is more expensive? Then on page 17, it actually states an opposite trend.	Text has been added to section 2.3.4 suggesting reasons for class shifting
Dr. Yan Zhou	2.6.1	Page 24: Did the IEA study which was conducted 13 years later (since 2004) conclude faster decoupling?	Evidence from the IEA report does not indicate faster decoupling, see figure 6 of the IEA report.
Dr. Yan Zhou	Throughout	Figure 4: Font size is too small to see	Figure size increased throughout the document
Dr. Y. Christy Zhōu	4.4	The authors did not explicitly state the assumptions that allow them to identify the parameters β_4 and β_5 (and the jump in the parameters before and after the introduction of the new standards).	Section 4.4 has been updated with greater clarity about the specification of β_4 and β_5 and the underlying assumptions.
Dr. Y. Christy Zhōu	4.4.1	In the worst case, when the identifying assumption falls apart, we should interpret the estimates of "pre buy" and "low buy" as conservative estimates.	This suggestion has been incorporated, with additional detail in footnote 12.
Dr. Y. Christy Zhōu	3	the authors can benefit by explaining specific variables that go into Equation (4) on page 58. In the current version, that does not appear until page 66 in the regression table.	A table has been added to section 3 to identify the variables used up front in the text, and clarifying text has been added related to EQ 4.

Dr. Y. Christy Zhōu	4.4	Also, the month variable is usually called the "month-of-the-year dummy variables" in a regression like this. Stating $month_t$ as a month will confuse readers who imagine the month as 1,2,…12; 13,14….24; 25…, which is typical when you have more than a year.	Text has been added clarifying that Month_t corresponds to month of year dummy variables, rather than a series of sequential months.
Dr. Y. Christy Zhōu	4.1 onwards	The authors may want to call $\Delta logClassi_t$ as $\Delta logSales_t$. Usually, the class is a dummy, so readers will be confused. What the authors mean are sales. Given that the authors estimate Equation (4) separately for each class, $\Delta logSales_t$ is sufficient and there is no need for $\Delta logSales_{it}$. The authors should state Equation (4) is estimated separately for each class before getting into Section 4.4.1; otherwise, readers will wonder why the authors do not have a dummy for each class on the right-hand-side.	We have updated the regression equations to $\Delta logSales_{it}$ as suggested by the reviewer. We appreciate the guidance on clarity
Dr. Y. Christy Zhōu	4.1 onwards	for the Equation on page 65, it is better to call "log Class 8" as "sales". It can be $\Delta logSales_{8,t}$ or another way depending on the authors' preference. Also, it may be helpful to add an equation number.	Equations have been changed to $\Delta logSales_{i,t}$ throughout, where i represents class. All equations are now numbered.
Dr. Y. Christy Zhōu	4.4.1	The authors stated on page 58 that they group months together in the pre and post dummies. The authors should clearly state the number of months they group in their baseline estimates. (If they do robustness and adjust the bandwidth, they can explain that later.)	As discussed in Section 4.4.1 we do not specify a baseline number of months, but instead test across the set of available months, comparing statistical tests for the different combinations of months.
Dr. Y. Christy Zhōu	4.4.1	First, for Figures 14-23, and Figures 25-28, it appears the authors plot the coefficients of seasonality dummies on top of the "pre buy" and "post buy" dummies, aka $\hat{\beta}_{1,m} + \hat{\beta}_4$ before the new regulation year, and $\hat{\beta}_{1,m} + \hat{\beta}_5$ after the	Text has been added to section 4.4.1 discussing that the figures only show the coefficients on the regulation variables. We only show the coefficients on the regulatory variables; seasonality is

		regulation is introduced. However, the authors only say "these models show … (Figure 14)" without informing me explicitly what are plotted in those figures. I recommend the authors state what they plot at least once. Then the rest of the figures would be self-explanatory	otherwise controlled for by the month dummies.
Dr. Y. Christy Zhōu	4.4.2 and 4.4.3	Second, given Equation (4) is the main equation, and Figures 14-15 are the main two figures, the authors should at least present the regression table of Equation (4) just like they have presented Table 13 for the Equation on page 65.	Regression tables have been added for Class 8 and Class 7 regression models
Dr. Amelia Regan	2.8	On page 33… Table 3 has the column heading, Estimated/Anticipated Costs, but the word expected shows up in the text of this paragraph on page 33. Is expected incremental = estimated? Or = anticipated? Or neither? Is this expected as in probabilistic expectation? Sorry if my concern appears silly, but this section of the text is difficult to follow.	These costs are incremental, which has been clarified in the text accompanying table 3. "Expected" has been changed to "estimated" as the regulatory costs discussed are derived from EPA estimates.
Dr. Amelia Regan	4.4.2	In Section 4.4.2, it might help if a sentence is added to explain the positive beta coefficient for one-month period post-regulation. I can guess that these were pre-ordered vehicles that for some reason did not arrive until the first month after the regulation was in place. Perhaps the sales were therefore not even governed by the new regulations? The six-month period post the 2004 regulation is actually months 2-6, not 1-6.	Text has been added under figure 16 per the reviewer's suggestion.
Dr. Amelia Regan	5	There is a statement on page 78 that makes sense but would clearer with a second sentence. "In the case of the 2010 regulations, significant pre-buy and low-buy periods partially cancel one another out, though	Thank you for the useful suggestion, the text in the conclusion has been updated based on the reviewer's suggestion.

		the period of significance was longer and larger for the pre-buy." MY SUGGESTION: By that we mean that the pre-buying before regulation and reduced purchases post-regulation are on the same scale. Together they reduce the effectiveness of the regulation.	
Dr. José Holguín-Veras	2.3.1	Page 15, section 2.3.1: The trucking companies that exercise pre-buy, low-buy, and class-switching are not in competitive markets. In these markets, rates are equal to marginal costs, and the carriers do not recover the fixed costs, and obviously cannot purchase new trucks. The companies that participate in pre-buy, low-buy, and class-switching behaviors are those that operate in markets where the companies have some pricing power. Owner-operators, intermodal-truck operators, and other small companies are not likely to do pre-buy, low-buy, or class-switching.	We agree with the reviewer. In a non-competitive market, firms have greater power to set the price of freight. In such instances, more expensive vehicles, or earlier purchases, may have little effect, as firms can adjust the freight rate to cover costs. Text has been added to section 2.3.1 incorporating the reviewer's suggestions.
Dr. José Holguín-Veras	2.3.4	Page 16, Section 2.3.4: It should be made clear that pre-buy, low-buy, and class-switching (together with do-nothing) are alternative choices for company managers.	Clarifying text has been added to section 2.3.4 Pre-buy may lead to low buy as vehicles have already been purchased. Low buy may also occur independently when purchasers are holding off because of price increases or unobserved or technical reasons. We emphasize that "do nothing" is also a viable pathway, but remains

			unobservable. Pre-buy and low-buy effects are the differences compared to the do-nothing/baseline. We're testing whether buyers diverge from their normal purchase cycles, and to what extent.
Dr. José Holguín-Veras	4.4	Section 4.4. Statements such as "Model results for Class 7 show visual evidence..." are too informal for a report of this nature. They need to support such conclusions with statistical tests. Figures are too small. Figure 21, by the authors' admission, shows results that are not statistically significant. In cases like that, it is better to simply add a note indicating that these results were not significant.	Informal statements have been removed and supporting statistics added where appropriate. Figure sizes have been increased to improve readability. Results that are not statistically significant carry important information – that we are not able to identify an effect. We believe it is important to provide the full evidence of our analyses.
Dr. José Holguín-Veras	4.1 onwards	Notation used in equations: 1. The vast majority of the equations in the report seem to be under-specified. Are alpha and beta vectors of parameters? Or single parameters? Please clarify. 2. In equation 3, is beta1 constant for all months t? 3. Is the variable "Month" in equation 2, a time index that start with 1... until the number of the last time period? Or is it a set of binary variables for each month?	Equations have been updated to improve clarity, along with supporting text.

2 Moderate

Reviewer	Section	Comment	Response
Dr. Yan Zhou	2.2	First, an overall summary of all the regulations (e.g., 2004, 2007 and 2010…) studied would be helpful to ensure the audiences understand the major policies implied by each of them. Table 3 did show the cost estimates of each regulation. However, a discussion of the major emission standards, and how that could change the vehicle cost but also reduce the operation cost would be very helpful to put some of the results into context.	We had added a summary of the regulations, per the reviewer's suggestion
Dr. Yan Zhou	3.3	Page 51 Section 3.3: Why do you choose 12 months as the analysis horizon? Is this the standard study period for pre-buy? What are the typical periods considered for pre-buy and low-buy analysis?	We have added text clarifying the choice of the 12-month period of analysis to section 3.3. While there are no standard practices, prior work (Rittenhouse and Zaragoza-Watkins) looked at an 8-month period, which this work extends, consistent with vehicle model year update and purchasing cycles.
Dr. Yan Zhou	4.2.1	For the oil price: Did you use monthly or annual oil price in the analysis? If monthly, have you tried using the average oil price over a few months (4-5 months for example)?	We tested a range of combinations for aggregating monthly fuel prices, including averaging over a period of 1 – 6 months. The coefficient on fuel price was affected by this exploratory analysis; however, the coefficients on other independent variables, including the coefficients on regulations, were essentially unchanged when examining aggregated fuel prices.
Dr. Yan Zhou	2.8	Table 3 did not show the expected cost impact of the 2014 regulations. Secondly, again, a brief description of each studied regulation and their impacts on vehicle ownership cost (vehicle, operation, maintenance) would be helpful. Third, did you find similar things for other regulations? Fourth, if this conclusion is true, then the take-way for audiences like DOE would be energy-	We have added text related to table 3 discussing the regulations in greater detail. The reviewer's point, that energy efficient technologies, while increasing up front capital costs, lead to lower operating and lifetime costs, is included in the discussion of the 2014 regulations.

		efficient technologies in HDV could be cost-effective for fleet operators	
Dr. Yan Zhou	Ex. Sum. And Conclusion	Figure 18-23: Please add discussions about whether the analysis shows one behavior is greater than the other. For example, does Figure 18 mean there was more "low buy" than "pre buy"? except Figure 18.	We have added text to the executive summary and concluding sections regarding the importance of also considering the duration of the effect, in addition to the magnitudes observed.
Dr. Yan Zhou	2.5.2	Section 2 Literature Review: Are there any literature on the energy and emissions impact of pre-buy and low-buy behaviors? If yes, could you add a short description of them?	The literature review has been updated to include a summary of potential emissions impacts from pre-buy/low-buy behaviors
Dr. Y. Christy Zhōu	4.4	To improve the validity of the assumption, first, I think the authors can benefit from stating it explicitly after introducing Equation (4) on page 58. Also, as I will mention under Charge Questions #3 and #4, after introducing Equation (4), the authors would benefit from stating the specific controls log(Xt) included in the Equation, which does not appear until page 66. The authors should explain log(Xt) right after Equation (4) before explicitly laying out the identifying assumption. Without introducing which variables go into the Equation, it will be unclear what β_4 and β_5 pick up. Third, the authors should discuss in which directions and in which cases their estimates are biased when their assumption does not hold up. I think the estimates can be conservative for the reasons that I stated above if their assumption does not hold up. The authors should lay out all possibilities that they believe might be possible.	Text has been added to section 4.4 below EQ 4 explicitly stating the effects that beta_4 and beta_5 are picking up. Text has also been added discussing the directions estimated.
Dr. Y. Christy Zhōu	Throughout	the authors can benefit from using more consistent descriptions	We have adjusted descriptions throughout the text to improve clarity

Dr. Y. Christy Zhōu	Throughout	Given that Figures 14-23, and Figures 25-28, plot coefficients, these figures should include confidence intervals.	Significance levels have been added to the plots to improve readability and identify significant coefficients
Dr. Y. Christy Zhōu	4.7	Section 4.7 is not the strongest part of the report because of all the additional assumptions needed for computing price changes for the elasticity. It is reasonable given that Section 4.4 to 4.6 are the main results. I recommend toning down Section 4.7 a little bit as potential implications or the suggestive outcome or something along that line.	We have added language that this section is an exploratory analysis
Dr. José Holguín-Veras	3.5	Another issue to be addressed is the tendency to make informal statements such as this one from page 53: "*Beta represents the "change in the percent change in Y for a one-unit 'change in the percent change' of X. The practical application of this coefficient is to consider it identical to the elasticity*". This statement is wrong from the mathematical point of view.	We agree with the reviewer's suggestion to remove, adjust, and support informal claims and have made adjustments to the text accordingly. It is incorrect that the statement is mathematically wrong. We have provided a citation to section 3.5 to a demonstration of this point.
Dr. José Holguín-Veras	2.5.4	Page 17, Section 2.3.5: This section conveys the impression that changes in freight mode choice are always forthcoming in response to price changes. In fact, shippers and receivers— who are the key decision makers in this matter—have considerable inertia, and decide on mode and vehicle changes after considering other factors, e.g., reliability. Freight mode choice does not change as easily as suggested in this section.	We have added text to a new section (2.5.4) discussing vehicle choice and class switching. This section includes discussion of the importance of considering the needs of shippers and receivers, not just carriers.
Dr. José Holguín-Veras	2.3.4	Page 30, Section 2.7: The review must be expanded to include papers and reports on vehicle choice.	We have added text to a new section (2.3.4) discussing vehicle choice and class switching
Dr. José Holguín-Veras	Throughout	Page 43, last paragraph: "Visual inspection" is not a formal method to assess regime shifts. If not supported by statistical tests, the analysis must be removed.	We have removed informal language and provided supporting statistics where relevant. We nevertheless consider visual inspection to be a useful aid in understanding our data and developing specifications.

Dr. José Holguín-Veras	3.5	Page 50, top two lines: Using the log differences imposes a functional form with constant elasticities. This is a strong assumption as in most cases elasticities are variable, i.e., as a function of price and other variables.	Text has been added to section 3.5 discussing the assumption of constant elasticities as reasonable here. We agree with the reviewer that the aforementioned assumption has its limitations in principle. For this study, the costs of regulation, and other associated factors, are likely felt similarly by all firms and the ranges in unit-level costs anticipated by different firms are likely small. We argue that the constant elasticity assumption holds as reasonable in this case, because, for small changes, the percent change and using a linear form produce similar results.
Dr. José Holguín-Veras	4.4	Section 4.4. The authors should not use statements such as "the coefficients for other explanatory variables are robust to model specification... and have been omitted in favor of discussion ..." This is not appropriate. To start, what is the meaning of "robust"? They must show the parameter values, and their statistics, to ensure that they are conceptually valid and statistically significant.	Class 8 and Class 7 regression summary tables have been added to the text to support claims of robustness, including standard errors and significance levels across a set of model specifications. "Robust" is commonly used in econometric studies to indicate that a coefficient does not change very much when other factors in the regression change. It is a term of art, not precision.
Dr. José Holguín-Veras	4.5	Section 4.5: Class Shifting 1. As explained in my answer to question 2, this section is problematic for numerous reasons, the analysis/theory framework is inadequate; the variables used cannot properly explain the phenomenon, among others. Moreover, the results are not conceptually valid. 2. The report seems to focus on the switch involving classes 7 and 8. Was a switch involving classes 8 and 9 considered? Or a switch involving three or more classes?	The title of the section has been changed to indicate that the class shifting analysis is exploratory. Otherwise we believe that the text endeavors to convey that these results are non-conclusive, and indicate "possible" results. Text has been added to the end of this section, further highlighting that the results are only indicative, and not comprehensive. We are uncertain what the reviewer is referring to as Class 9 vehicles; the classes (by weight) studied in this analysis are as laid out in Section 2.1 and table 1.

3 Major

Reviewer	Section	Comment	Response
Dr. José Holguín-Veras	4.5 and 4.7	In summary, the data sources are: 1. Appropriate to obtain a general idea of the existence of pre-buy and low-buy behaviors, and to quantify direct elasticities at the market level; and 2. Inappropriate for analyses of class-switching and estimation of cross-elasticities.	We agree with the reviewer's comments in point 1. Regarding point 2, we have added clarifying text that these results are both exploratory, and only indicative of the potential for class shifting. We respectfully disagree with the reviewer's statement that the methods employed are inappropriate for class-switching and estimating cross price elasticities. The methods employed in this analysis are statistically rigorous, methodologically appropriate, and employ the best available data. The state of published knowledge on the study of class-switching is limited and in its infancy, and we believe that the approaches employed here, using macroeconomic factors, can support further exploration of the class-switching issue. Regarding cross-price elasticities, the analysis was structured such that the direct outputs of our models would return elasticities. Based on estimated vehicle prices and EPA's own estimated price increases we estimate the cross-price elasticity. This is a common approach, consistent with best practices and while micro-level transactional data offers an alternate approach it does not invalidate this work, and is instead a complement. The reviewer's statements that the elasticities are larger than anticipated is best considered in the context of the duration over which we identified effects. These elasticities are not long-term, or annual estimates, but instead reflect behaviours on the order

			of months, not years, as is typically reported. Furthermore, we emphasize that pre-buy and low-buy effects of zero change are also reflected in the results, implying an elasticity of zero.
Dr. José Holguín-Veras	4	Section 4 … is repetitive and unnecessarily long (to a great extent because it discusses results that are not statistically significant and not conceptually valid). Section 4 is problematic in other respects as it does not contains the model statistics—such as t-values, R2, and F— that reviewers need to judge the validity of the results. In my view, this is unacceptable. Focusing on results that are statistically significant and conceptually valid; and adding a comprehensive appendix with the final models obtained (and the corresponding statistics) would lead to a more concise, readable, and useful document.	We have added supporting statistics and summary tables where relevant to support the reader. We respectfully disagree with the reviewer regarding non-significant results, and chose to leave those in the analysis. We believe that presentation of non-significant findings is just as important as findings with statistical significance, as they inform the reader of the completeness of the analysis, and identify areas of study for the benefit of the future researcher.
Dr. José Holguín-Veras		the conclusions reached regarding class-switching and elasticities are very difficult to defend.	As mentioned in other responses we have endeavored to be clear that the discussions of price elasticities and class-switching are exploratory, and have added supporting text accordingly.
Dr. José Holguín-Veras	4.7	Moreover, the absolute values of the estimated elasticities (0.558 to 2.347) are simply too high to be credible. My conclusion is that the data do not support a solid estimation of elasticities.	The text includes suggestions for why the estimated elasticities may be higher than the reviewer expects, including that the effects are short-lived and likely capture other unobserved regulatory effects. Notably, an elasticity of zero is also a potential outcome of this analysis for consideration. Reference to this has been added to the text (see section 4.7).
Dr. José Holguín-Veras	4.7	Equally concerning are the results for cross elasticities, which were found to range between 0.681 and 1.712. As amply established in the	See above comment

		transportation literature on cross-elasticities, relative to each other, cross elasticities ought to be smaller than the corresponding direct elasticities.	
Dr. José Holguín-Veras	Throughout	In its current version, the report is unnecessarily long, repetitive, with illegible figures, and lacking technical details about the models discussed. There are numerous ways to improve it. For instance: 1. Increase the size of figures to make them readable. In most cases, the font size is 5 or less. 2. Include all the statistics of the models discussed. 3. Instead of copying / pasting / adjusting the text to fit the results, summarize the results in tables (with all relevant statistics). 4. The authors discuss results that are not statistically significant, and even results that are not conceptually valid (that the authors struggle to explain). I suggest removing all discussions of non-significant and not conceptually valid results. A focused discussion of statistically significant and conceptually valid results would cut the size of the document by at least 50%.	We have increased the size of figures and restructured the page layout to improve readability. Model statistics have also been included. As noted in our other response, we believe that including non-significant findings is important and have chosen to leave them in the text.
Dr. José Holguín-Veras	2.3.5	The literature review is very weak, particularly on topics directly relevant to class-switching. The authors must expand the literature review to include a broader discussion of freight mode choice and freight vehicle choice, and the implications of the chief findings from the	The literature review has been updated to include the reviewer's suggestions; see section 2.3.5.

		literature on the research reported in the document.	

January 21, 2021

Analysis of Heavy-Duty Vehicle Sales Impacts due to New Regulation (October 9, 2020): Peer Review

Final Report

Prepared for

US EPA OAR/OTAQ
2000 Traverwood Dr.
Ann Arbor, MI 48105

Prepared by

RTI International
3040 E. Cornwallis Road
Research Triangle Park, NC 27709

RTI Project Number 0215574.004.034

EnDyna

RTI International

TABLE OF CONTENTS

1 Introduction

The U.S. Environmental Protection Agency (EPA), Office of Transportation and Air Quality (OTAQ), contracted with RTI International for an independent external letter-style peer review of the draft final report *Analysis of Heavy-Duty Vehicle Sales Impacts due to New Regulation* (dated October 9, 2020), prepared by Eastern Research Group (ERG). The report is referred to throughout this peer review as the "ERG draft report."

EPA's peer review guidelines specify that all influential scientific and technical work products must undergo independent peer review per specific agency protocols. Under subcontract to RTI, EnDyna was tasked with managing an independent external peer review process to evaluate the ERG draft report. EPA's goal for this peer review was to ensure the use of the highest quality science in its predictive assessments. By so doing, EPA seeks to assure its stakeholders that this analysis has been conducted in a rigorous, appropriate, and defensible way.

The peer reviewer selection process for the ERG draft report involved selecting three expert peer reviewers who were available to participate in the peer review, including preparing individual written peer review comments during a specific time frame. In recruiting these expert peer reviewers, EnDyna evaluated the qualifications of peer reviewer candidates, conducted a thorough conflict of interest (COI) screening process, and independently selected the peer reviewers. RTI and EnDyna then provided management and oversight of the independent external peer review process. RTI and EnDyna produced this report that documents the peer review process and summarizes the peer reviewer comments on the Charge Questions.

The sections below provide background on the ERG draft report, describe EnDyna's process for identifying and selecting expert peer reviewers for this peer review, provide EPA's scope for the peer review of the ERG draft report, discuss the peer review teleconference and issues encountered affecting the independence of this peer review, discuss the addition of an alternate peer reviewer, and outline the organization of this report.

1.1 Background on ERG Draft Report

EPA has been examining the effects of emissions standards on sales of heavy-duty vehicles. The implementation of regulations that increase the capital costs of new vehicles could influence end-user purchase decisions, especially when access to capital is limited. Instead of purchasing a new (more expensive) vehicle, end users may choose to maintain their existing vehicles to extend their lives. Having a means to estimate the sales impacts of regulatory standards would enhance EPA's ability to examine the economic and environmental effects of the standards. From the abstract of the report:

> Heavy-duty vehicle activity is a major source of criteria pollutants in the transportation sector, contributing 35% more particulate matter emissions than light-duty vehicles in the United States. The federal government has implemented a series of policies aimed at reducing pollution from heavy-duty vehicles, which have cut particulate matter and nitrogen oxide emissions by 90% on a per unit activity basis since 1997. These regulations have led to millions of dollars in estimated health and environmental benefits, but do not come without cost.
>
> Using sales data and time-series econometric methods, this work finds evidence of pre-buy and low-buy behaviors around regulations, as well as possible class-shifting. Pre-buy and low-buy behavior effectively reduce the effectiveness of proposed regulations, as industry purchases more vehicles than they normally might prior to the regulation in order to avoid having to pay higher prices for regulation compliant

> vehicles after the regulation goes into effect. As such, the effect of the regulation is tempered as the vehicles purchased just prior to regulations persist in the fleet long after the regulation goes into effect. We [ERG] extended this analysis to explore the effect of predicted regulatory cost on pre-buy and low-buy behavior, with mixed evidence supporting greater pre-buy and low-buy effects with greater anticipated cost.

This study also identifies evidence of potential class-shifting, which has not been widely discussed in the literature. In instances where regulatory pressure might lead a firm to purchase a Class 8 vehicle when they might normally have purchased a Class 7 vehicle because of economic constraints, the effect of the regulation may again be tempered, given that larger trucks have larger engines and thus higher emissions, which runs counter to the goals of the regulations.

The ERG draft report meets the criteria for "influential scientific information" under the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review*. Therefore, EPA had determined that this ERG draft report contained new scientific information that was subject to peer review.

1.2 Identification and Selection of Expert Peer Reviewers

The peer reviewer selection process under WA 4-34 involved selecting three subject matter experts (SMEs) who were available to participate in the peer review, including preparing individual written comments, during a specific time frame. In recruiting the peer reviewers, EnDyna evaluated the qualifications of peer reviewer candidates, conducted a thorough COI screening process, and independently selected the peer reviewers. These activities are discussed in more detail below.

1.2.1 Identification of SMEs

As a subcontractor to RTI, EnDyna participated in a WA 4-34 kickoff conference call with RTI and EPA OTAQ on August 25, 2020, to discuss the qualities for potential SMEs.

EnDyna was tasked with independently selecting peer reviewers who collectively had the background and proven expertise for the following three areas:

1) Academic literature on vehicle demand modeling with a preference for research on heavy-duty vehicles,
2) Regression analysis, and
3) Statistical analysis involving time-series data.

The SMEs were identified through literature and internet searches of scientific journals, professional societies, universities, scientific meetings, nonprofit organizations, and government agencies. EnDyna worked to identify SMEs representing a range of affiliations: academia, nonprofit organizations, industry, trade associations, consulting, and government research facilities.

EnDyna contacted 24 people, of whom 10 people were interested in participating, provided their CV/resume (or bio), and were also available during the anticipated peer review time frame. EnDyna researched readily available information about the 10 interested individuals for relevant experience and demonstrated expertise in the subject matter of the ERG draft report, as demonstrated by educational degrees attained, research and work experience, publications, awards, and participation in relevant professional societies.

EnDyna reviewed those 10 interested individuals' CVs/resumes (or bios) and removed one individual from further consideration because of limited relevant expertise. EnDyna contacted the remaining nine

interested individuals to request a signed COI form and a signed non-disclosure/confidentiality agreement (NDA). Three of those remaining nine interested individuals did not complete a COI form or NDA and thus were removed from further consideration.

Completed COI forms and NDAs were received from each of the remaining six interested individuals. EnDyna removed one of the remaining six interested individuals from further consideration after additional review of his qualifications and publications indicated that his expertise focused on discrete choice models instead of relevant experience/expertise in time-series regression models.

1.2.2 Peer Reviewer Candidates

From the remaining five interested individuals who completed a COI form and NDA, EnDyna included all of them, resulting in five candidate peer reviewers who best met the required fields of expertise for this peer review.

The names and affiliations of the five candidate peer reviewers, as well as a brief summary of their qualifications, are provided in Table 1.1. A CV/resume for each of the five candidate peer reviewers who best met the required fields of expertise (see Table 1.1) was provided to RTI and EPA separately.

Table 1.1. Experience/Expertise Matrix for Peer Reviewer Candidates

Name	Affiliation	Academic Degrees	Areas of Expertise		
			Academic literature on vehicle demand modeling	Regression analysis	Statistical analysis involving time-series data
José Holguín-Veras, PhD	• Rensselaer Polytechnic Institute, Department of Civil and Environmental Engineering • William H. Hart Professor • Director of Volvo Research and Educational Foundations (VREF) Center of Excellence for Sustainable Urban Freight Systems (COE-SUFS) • Director of the Center for Infrastructure, Transportation, and the Environment (CITE)	• PhD, University of Texas at Austin, Transportation (1996) • MSc (Magister Scientiarum), Universidad Central de Venezuela, Transportation (1984) • BSc, magna cum laude, Universidad Autónoma de Santo Domingo, Dominican Republic, Civil Engineering (1981)	SME* vehicle demand modeling with a preference for research on heavy duty vehicles: SME*	SME	SME
Amelia C. Regan, PhD	• University of California at Irvine • Professor of Computer Science • Professor of Civil (Transportation Systems) Engineering	• PhD, University of Texas at Austin, Civil (Transportation Systems) Engineering (1997) • MSE, University of Texas at Austin, Civil (Transportation Systems) Engineering (1995) • MS, Johns Hopkins University, Applied Mathematics (1990) • BAS, University of Pennsylvania, Systems Engineering (1987)	SME vehicle demand modeling with a preference for research on heavy duty vehicles: SME	G	G**
Clifford Winston, PhD	• Brookings Institution • Searle Freedom Trust Senior Fellow, Economic Studies Program	• PhD, University of California at Berkeley, Economics (1979) • MSc, London School of Economics, Economics (1975) • AB, University of California at Berkeley, Economics (1974)	SME vehicle demand modeling with a preference for research on heavy duty vehicles: G	G	G

Table 1.1. Experience/Expertise Matrix for Peer Reviewer Candidates

Name	Affiliation	Academic Degrees	Areas of Expertise		
			Academic literature on vehicle demand modeling	Regression analysis	Statistical analysis involving time-series data
Yan (Joann) Zhou, PhD	• Argonne National Laboratory, Energy Systems Division • Group Manager, Vehicle and Energy Technology & Mobility Analysis • Principal Transportation Systems Analyst	• PhD, Clemson University, Civil (Transportation) Engineering (2010) • MS, Clemson University, Civil Engineering (2008) • BS, Wuhan University of Technology, Wuhan, P. R. China, Automotive Engineering (2003)	SME vehicle demand modeling with a preference for research on heavy duty vehicles: SME	SME	SME
Yìchén (Christy) Zhōu, PhD	• Clemson University • Assistant Professor, Department of Economics • Postdoctoral Fellow, Resources for the Future (RFF) (August 2016–July 2017)	• PhD, University of Maryland at College Park, Economics (2016) • MA, University of Maryland at College Park, Economics (2014) • BA with *Distinction*, University of Virginia, Mathematics and Economics (2010) • BA student at large, Huazhong University of Science and Technology, P.R. China (2006–2008)	SME*** vehicle demand modeling with a preference for research on heavy duty vehicles: G***	SME	G

Key:
SME: Primary area(s) of expertise/experience
G: Good knowledge/experience
L: Limited knowledge/experience

Notes:

*Freight transportation demand modeling is Dr. Holguín-Veras's primary expertise. His work on freight demand modeling focuses on enhancing the realism of spatial price equilibrium models and development of simplified modeling techniques. His work on freight generation and freight trip generation has led to the development of freight trip generation models.

** Dr. Regan indicated she had "quite a bit of recent experience modeling time-series data," so she considered that rating as borderline but stated she would "prefer to be conservative" by using G. (EnDyna had rated that as SME for Dr. Regan.)

*** Dr. Christy Zhōu's main area of expertise is vehicle demand estimation (of purchasing decisions rather than trip decisions). Dr. Zhōu indicated that the subrating under Column 1 would be G because the vehicle demand models she has estimated were for passenger vehicles.

1.2.3 COI Screening Process

EnDyna conducted COI screening for the five candidate peer reviewers who best met the required fields of expertise (see Table 1.1) to ensure that the SMEs had no COI or appearance of the lack of impartiality. The COI screening was conducted in accordance with EPA's *Peer Review Handbook* and involved each SME completing a COI questionnaire (COI form) to determine if they were involved with any other work or organizations that might create an actual, potential, or perceived COI for this peer review. Section 7 provides the COI form and NDA for this peer review.

Completed COI forms and a signed NDA were received from each of the five candidate peer reviewers.

Although some of the candidate peer reviewers disclosed previous or current research funding in related fields, it was EnDyna's opinion that such research funding opportunities and relationships with research funding agencies and organizations would not likely pose an actual or potential COI. SMEs with expertise in areas related to this peer review are likely to engage in obtaining research funding and conducting related research or similar project activities, and those disclosures were included on their COI forms.

Dr. Holguín-Veras was careful to disclose on his COI form that he conducted sporadic consulting work with transportation agencies and companies and indicated this was related to his employment as a faculty member at Rensselaer Polytechnic Institute. EnDyna interpreted his approach to such disclosure as documenting occasional consulting related to his role as faculty at Rensselaer Polytechnic Institute that was either not during the preceding 2 years or did not provide 15% or more of his annual compensation (either of which would have required fuller disclosure of consulting activities on the COI form). EnDyna concluded it was not likely that Dr. Holguín-Veras's sporadic consulting work could represent an appearance of the lack of impartiality for this peer review, which could potentially lead to Dr. Holguín-Veras's impartiality as a peer reviewer to be questioned (if selected as a peer reviewer).

1.2.4 Selection of Peer Reviewers

EnDyna evaluated each peer reviewer candidate's credentials to select three SMEs who, collectively, cover the areas of expertise needed for this peer review, have no actual or potential COI or appearance of the lack of impartiality, and were available to complete the peer review within the desired time frame, including preparing individual written comments.

After review and consideration of the available information, EnDyna selected the three peer reviewers summarized in Table 1.2 on September 29, 2020. EnDyna also selected an alternate peer reviewer in case one of the three selected peer reviewers became unavailable during the peer review time frame.

Table 1.2. Selected Peer Reviewers

Name	Areas of Expertise		
	Academic literature on vehicle demand modeling	**Regression analysis**	**Statistical analysis involving time-series data**
Selected Peer Reviewers:			
Amelia C. Regan, PhD	SME vehicle demand modeling with a preference for research on heavy duty vehicles: SME	G	G**
Yan (Joann) Zhou, PhD	SME vehicle demand modeling with a preference for research on heavy duty vehicles: SME	SME	SME
Yìchén (Christy) Zhōu, PhD	SME*** vehicle demand modeling with a preference for research on heavy duty vehicles: G***	SME	G
Alternate Peer Reviewer:			
José Holguín-Veras, PhD	SME* vehicle demand modeling with a preference for research on heavy duty vehicles: SME*	SME	SME
Key: SME: Primary area(s) of expertise/experience G: Good knowledge/experience L: Limited knowledge/experience			
Notes: See Table 1.1 for definitions of asterisks			

EnDyna completed the Peer Review Charge Document, which included the Charge Questions (see Section 2) that EnDyna had developed and were approved by EPA. The three selected peer reviewers — Dr. Amelia Regan, Dr. Y. Christy Zhōu, and Dr. Joann Zhou — were issued a Peer Review Charge Document on October 13, 2020.

1.3 Scope of Peer Review

EPA approved the scope of this peer review as defined by EnDyna for the ERG draft report to focus the peer review process effectively on the Charge Questions (see Section 2). The peer reviewers were directed to keep their written peer review comments within the EPA scope, as defined below:

The scope of this letter-style peer review is technical in nature, reviewing the methods, data quality, data sources, underlying assumptions, and the overall strengths and limitations of the study. EPA is especially interested in comments that focus on the validity or scientific merit of the methodology and that identify any significant weaknesses in the scientific information from the methodology.

- **Peer reviewers should focus on providing comments on the technical nature of the report, and its consistency with the state of current science as you understand it. The peer reviewers should evaluate the analysis used to develop the proposed methods and the suitability of those methods to estimate sales, pre-buy, and other impacts for use in policy analysis.**
- **Peer reviewers should also focus on the clarity and completeness of the presentation in the draft report. Because the review is technical in nature, the peer reviewers should not focus on editorial style.**

1.4 Peer Review Teleconference

WA 4-34 required a peer review teleconference to give peer reviewers the opportunity to ask clarifying questions related to the report. To facilitate an effective peer review teleconference, EnDyna requested any major questions from the peer reviewers about the ERG draft report. EnDyna synthesized and clarified each of those major questions, compiled them, and submitted those major questions to RTI and EPA on October 28, 2020. EnDyna explained that those were the major scientific/technical questions from the peer reviewers that would be on the agenda for the peer review teleconference scheduled for November 4, 2020. EnDyna requested that EPA be prepared to provide responses to those peer reviewer questions at the peer review teleconference.

Section 6 provides the agenda for the November 4, 2020, peer review teleconference, which included the peer reviewer questions that were compiled by EnDyna and submitted to RTI and EPA on October 28, 2020. The agenda also included the following Peer Review Teleconference Ground Rules (from the Peer Review Charge Document):

- An external peer review is intended to solicit individual reviewer feedback to increase the independence of the peer review process.
- The peer reviewers are not asked to, and should not attempt to, form consensus or collective recommendations, ratings, or opinions, and peer reviewers must understand that they should provide individual feedback on the research product.
- Any EPA staff who may attend the peer review teleconference can only provide background information on the research product to the peer reviewers, which can occur only during the teleconference run by EnDyna and at EnDyna's request.
- The peer review teleconference will not include discussion related to EPA's policies and decisions or current or proposed EPA regulations.

One of the three selected peer reviewers, Dr. Amelia Regan, unexpectedly did not call into the November 4, 2020, peer review teleconference and did not respond to attempts by EnDyna to contact her during the initial 15 minutes of the teleconference or the subsequent 2 days (see Section 4.2). After

the teleconference, RTI sent Dr. Regan information about the teleconference (copying EnDyna), but neither RTI nor EnDyna received any response from Dr. Regan from that communication. Later, when Dr. Regan finally answered a phone call from EnDyna on November 16, 2020, EnDyna confirmed that Dr. Regan would review the information sent by RTI about the teleconference before completing her written peer review comments. Given the uncertainty about Dr. Regan's availability and whereabouts, EnDyna contacted the alternate peer reviewer (see Table 1.2) on November 6, 2020 (see Section 1.5).

1.5 Addition of Alternate Peer Reviewer

EnDyna contacted the alternate peer reviewer, Dr. José Holguín-Veras, on November 6, 2020, and obtained his agreement to participate in this peer review. EnDyna issued a Peer Review Charge Document to Dr. José Holguín-Veras on November 6, 2020. This was necessary to ensure that at least three expert peer reviewers would provide written peer review comments.

1.6 Organization of Report

This peer review report comprises six sections:

- ***Section 1*** describes the process for this independent external letter-style peer review.
- ***Section 2*** presents the Charge Questions sent to each of the peer reviewers for comments.
- ***Section 3*** includes the summary of the peer reviewers' comments.
- ***Section 4*** consists of each individual peer reviewer's comments.
- ***Section 5*** provides the curriculum vitae for each peer reviewer.
- ***Section 6*** provides the agenda for the peer review teleconference.
- ***Section 7*** provides the COI form and NDA for this peer review.

2 Charge Questions

The objective of this external letter-style peer review was to obtain written peer review comments from individual experts to conduct an independent external peer review and evaluate the ERG draft report to 1) ensure the use of the highest quality science in EPA's predictive assessments and 2) for EPA to assure its stakeholders that this analysis was conducted in a rigorous, appropriate, and defensible way. RTI and EnDyna charged each peer reviewer with evaluating the ERG draft report and responding to the eight Charge Questions presented in Table 2.1.

Table 2.1. Charge Questions

1. Does the overall presentation in the draft report describe the data and methods sufficiently to allow the reader to form a general view of the quality and validity of the analysis performed?
2. Are the data sources and assumptions appropriate for the analysis conducted? If yes, explain why. If not, describe all issues identified regarding the validity of data sources and assumptions and provide suggestions and references for other available data that might be used to improve this analysis. As relevant, describe how the validity of data sources and assumptions could be more clearly described in the report.
3. Is the description of the analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made in this analysis? If yes, explain why. If not, explain how the analytic methods and procedures could be more clearly described in the report.
4. Are the analytic methods and procedures employed technically appropriate and reasonable? Are the analytic methods and procedures applied appropriately, given the state of current science as you understand it? If yes, explain why. If not, explain why the methodology was not technically appropriate. Provide a description of each identified strength or weakness regarding technical appropriateness. Please distinguish between cases involving reasonable disagreement in methodology as opposed to cases where you conclude that any analytic methods and procedures in the draft report involve specific technical errors.
5. Are the results and conclusions of the analysis in the draft report presented in appropriate ways? Were the conclusions in the draft report reasonably drawn? Do the conclusions follow logically from the results of the analytic methods and procedures?
6. Are the selected figures, tables, and equations well-chosen and constructed to assist the reader in understanding the approach, analytic methods and procedures, results, and conclusions? If yes, explain why. If not, explain how the figures, tables, and equations could be improved to describe the approach, analytic methods and procedures, results, and conclusions more clearly in the report.
7. Are there any other issues or concerns with the validity or scientific/technical merit of this report?
8. If you are aware of better methods, tools, and available research employed and documented elsewhere to estimate sales, pre-buy, and other such impacts for use in policy analysis, provide suggestions for how they might be used to improve this report and also provide the associated references.

3 Summary of Peer Reviewers' Comments

This section provides a summary of the peer reviewers' comments, concerns, and suggestions regarding the Charge Questions (see Section 2), based on the individual peer reviewer's final written peer review comments (see Section 4).

1. Does the overall presentation in the draft report describe the data and methods sufficiently to allow the reader to form a general view of the quality and validity of the analysis performed?

All reviewers generally agreed that the overall presentation in the ERG draft report is sufficient as a good general view of the analysis performed. Dr. Regan stated the overall presentation is exceptionally clear, but also noted that Section 2.5.2 is challenging to understand and explained how use of the word "expected" on page 33 is unclear.

Dr. Holguín-Veras suggested that readers without time to read the entire report would benefit from 1) changing the current Abstract to an Executive Summary and 2) moving some report contents from the current Conclusion to that suggested Executive Summary to present key takeaways from this study. This reviewer also suggested that the current Introduction and the recommended Executive Summary clarify that although the heavy-duty vehicle (HDV) regulation covers from Class 2b through Class 8, this study focuses on Classes 6 through 8 because of data limitations.

2. Are the data sources and assumptions appropriate for the analysis conducted? If yes, explain why. If not, describe all issues identified regarding the validity of data sources and assumptions and provide suggestions and references for other available data that might be used to improve this analysis. As relevant, describe how the validity of data sources and assumptions could be more clearly described in the report.

Drs. Regan and Joann Zhou both commented that the data sources and assumptions seem appropriate for the analysis conducted. Additionally, Dr. Regan commented that the explanation of each is clear. Dr. Zhou suggested adding a table at the beginning of Section 3, Data and Methodology to summarize all the data considered in the analysis and modeling and also suggested several specific clarifications related to Table 3.

In contrast, Drs. Holguín-Veras and Christy Zhōu provided detailed comments about the data and assumptions. Dr. Holguín-Veras stated that the data sources are 1) appropriate to obtain a general idea of the existence of pre-buy and low-buy behaviors and to quantify direct elasticities at the market level and 2) inappropriate for analyses of class-switching and estimation of cross-elasticities. Dr. Zhōu stated the data sources and assumptions are appropriate for the analysis conducted, given data constraints the authors had, but emphasized several caveats: 1) they are not the most ideal for this type of analysis, but 2) are still useful to understand the effect of regulation on HDV sales in the short run.

Aggregate Data for Pre-buy and Low-Buy Analysis

Dr. Christy Zhōu stated that the ideal dataset contains transaction-level data or very fine registration-level data, which are very costly to obtain. She stated the second best type of dataset are datasets that are slightly more aggregate than this ideal dataset. For example, sales could be aggregated to make-by-class-by-year level (better at the state level but acceptable if at the national level) or to make-by-class-by-

buyer-type-by-year level. Dr. Zhōu also acknowledged that obtaining such disaggregated datasets is not always easy.

Dr. Holguín-Veras explained that the type of aggregate data used in the ERG draft report is unable to identify the root behaviors at the core of transportation choice processes. However, he observed that if the objective was exploratory analyses and only aimed at getting a general idea about pre-buy and low-buy effects, then it may be appropriate. He strongly recommended further confirmatory research if the objective was to use the findings to support policy-making. Dr. Holguín-Veras's comment is consistent with Dr. Christy Zhōu's caveat (see above) that the data sources and assumptions in the ERG draft report are still useful to understand the effect of regulation on HDV sales.

Dr. Christy Zhōu provided additional comments about the appropriateness of the level of class-by-month dataset used in the ERG draft report, stating that it is appropriate with one advantage and one shortcoming:

- The advantage is obtaining monthly data, which Dr. Zhōu noted is limited to pinning down the short-run effect, but this is the area of focus for the report.
- The shortcoming is the dataset lacks cross-sectional variation because those data are aggregated to class (Classes 7, 8, and 9), which prevents exploiting cross-sectional variation that is typically used in panel data (either in a difference-in-difference model, a fixed-effects model, or an event-study model with fixed effects).

Dr. Zhōu further explained that the ERG draft report instead uses temporal variation, due to constraints from the data sources used in ERG's analyses. She believed that the approach in the ERG draft report is appropriate to estimate the short-run effect of emission standards on sales, as specified in the main Equation (4).

Equation 4

Dr. Christy Zhōu commented that the ERG draft report does not explicitly state the assumptions related to identifying parameters for Equation 4. She provided detailed comments about the appropriateness of what the reviewer described as ERG's implicit assumption imposed by specifying Equation 4. She also commented that this implicit assumption ruled out, or assumed away, any strategic behavior HDV sellers or buyers may have done to reduce the impact of the regulation other than the main pre-buy and low-buy effects. Dr. Zhōu explained that in the case when this implicit assumption fails the estimates of pre-buy and low-buy effects should be interpreted as conservative estimates.

Dr. Zhōu commented that the validity of this implicit assumption could be improved by stating it explicitly after introducing Equation 4 (page 58) in the ERG draft report. She also stated that the validity of this implicit assumption could be improved by explaining the specific controls log(Xt) included in Equation 4 and suggested including that log(Xt) explanation right after Equation 4 and before explicitly stating this implicit assumption.

Additionally, she suggested including discussion about in which directions and in which cases the estimates are biased when this implicit assumption fails. She encouraged laying out all possibilities in the report and provided an example of a possible exaggeration of pre-buy and low-buy effects.

Aggregate Data to Estimate Class-Switching

Dr. Holguín-Veras expressed concerns that aggregate data are not useful to evaluate class-switching. He explained that aggregate data do not contain class-specific descriptors (e.g., cargo capacity and operational costs) that could be used as independent variables for econometric models. He stated that the consensus position established in the literature on freight mode and vehicle choice (with root behaviors that are closely related to those in class-switching) is that using disaggregate data is, by far, the best approach.

Aggregate Data to Estimate Cross-Elasticities

Dr. Holguín-Veras also expressed concerns about using aggregate time-series data to estimate elasticities. He stated that aggregate time-series data can be used to estimate direct elasticities at the market level. The reviewer also stated, however, that using aggregate data to estimate cross-elasticities is challenging in the best of circumstances because these effects cannot be easily captured by aggregate data. This reviewer emphasized that estimating cross-elasticities is not possible in the absence of class-specific data about purchase prices and other descriptors of the vehicles in a class.

3. Is the description of the analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made in this analysis? If yes, explain why. If not, explain how the analytic methods and procedures could be more clearly described in the report.

The reviewers provided a range of comments about whether the description of the analytic methods and procedures is clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made in this analysis. The reviewers also provided numerous specific comments about how the analytic methods and procedures could be more clearly described in the report.

Overall Impressions

The range of comments about how well the ERG draft report describes the analytic methods and procedures used in this study varied as follows:

- Dr. Holguín-Veras commented that, overall, the description of the analytic methods and procedures is clear and detailed enough for a reader to understand what was done in this study. He suggested, however, that including an overall summary of all the regulations (e.g., 2004, 2007, 2010) included in this study would be helpful to ensure that readers understand the major policies implied by each of them. Dr. Holguín-Veras acknowledged that Table 3 shows the cost estimates of each regulation but explained that including a discussion of the major emission standards (along with how they could change the vehicle cost but also reduce the operation costs) would be very helpful to put some of this study's results into context.
- Dr. Regan commented only about Section 3, Data and Methodology. She stated that Section 3.1 (Time Series Inputs) is exceptionally clear and observed it mainly presents information about the data. With respect to Section 3.2 (Testing for Unit Roots), she made two main points: 1) the execution of the augmented Dickey–Fuller (ADF) test is appropriate and clearly explained and 2) the addition of the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test and explanation of its meaning is also very helpful. Dr. Regan stated that Section 3.3 (Econometric Framework) and

Section 3.4 (Leads and Lags) are very clear and illuminating (though acknowledging this observation from the perspective of an educated reader, but not an econometrician).

- Dr. Christy Zhōu stated that the description of the analytic methods and procedures is clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made in this analysis. Nevertheless, she commented that the ERG draft report could benefit from using more consistent descriptions of the model (see below).
- Dr. Joann Zhou commented that, in general terms, the ERG draft report is clearly written. She, however, emphasized that Section 4, Results and Discussion is the exception. Dr. Zhou made two main points about Section 4: 1) it is repetitive and unnecessarily long because Section 4 discusses results that are not statistically significant and not conceptually valid and 2) it does not contain the model statistics—such as t-values, R2, and F—that reviewers need to judge the validity of the results. To correct what Dr. Zhou described as unacceptable problems, she recommended 1) limiting the discussion to results that are statistically significant and conceptually valid and 2) adding a comprehensive appendix with the best models obtained and the corresponding statistics (even if these models are not statistically significant and conceptually valid). Dr. Zhou argued that those recommended solutions would lead to a more concise, readable, and useful document that will reassure readers that the work conducted has rigor.

Descriptions of Model

Dr. Christy Zhōu further explained her observations about inconsistencies in the model description that she noticed in the report.

- First, Dr. Zhōu observed the ERG draft report changes how it describes the model: in the introduction, it describes the use of time-series methods but then in the main analysis, it describes the use of difference-in-differences.
- Second, when the ERG draft report showed Equation 4 and the results, it appeared to Dr. Zhōu that it uses an event-study model because the presentation of $\beta_4 Pre_{t-m}$ is usually written as dummies (in plural) before an event and $\beta_5 Pre_{t+m}$ as dummies afterward. Dr. Zhōu explained that it was not until Table 13 that she realized the approach had one pre-dummy and one post-dummy.

Dr. Zhōu offered three recommendations regarding the description of the methodology:

- The report should not describe the model as difference-in-differences because there is no control group (a cross-sectional control group).
- Although the authors implicitly used no-regulation years for the same class as a control to identify β_4 and β_5, this would be better stated after Equation 4 when discussing identifying assumptions.
- In observing that the authors do have first-difference, this should be stated when explaining the variables in Equation 4. Right after Equation 4, the authors should explain that the left-hand-side variable is a detrended first-difference variable of sales.

Equations

Dr. Regan commented that it was especially helpful that key equations are numbered and intermediate (explanatory) ones are not. As described above, Dr. Christy Zhou commented again (see Charge Question #2) that the report would benefit from explaining the specific variables that went into

Equation 4 on page 58. She observed that in the ERG draft report that information does not appear until page 66 in the regression table.

Dr. Christy Zhōu pointed to Table 13 and commented that for the equation on page 65 it appears that pre- and post- are "pre 2 months" and "post 2 months" and stated this made Equation 4 unclear in comparison. This reviewer observed that the ERG draft report states on page 58 that this study's approach grouped months together in the pre- and post-dummies. Dr. Zhōu commented that the report should clearly state the number of months grouped in the baseline estimates. Finally, Dr. Christy Zhōu provided minor suggestions for a few specific equations.

Dr. Holguín-Veras expressed concerns about the tendency to make informal statements in the ERG draft report. He provided an example from such observations in the ERG draft report that he stated is wrong from a mathematical point of view:

> Beta represents the "change in the percent change in Y for a one-unit 'change in the percent change' of X. The practical application of this coefficient is to consider it identical to the elasticity. (from page 53 of ERG draft report)

Dr. Joann Zhou pointed to Section 4.2 (page 55 of the ERG draft report) and commented that it is unclear and lacks exact identification of the dependent variable. She stated it is unclear whether the dependent variable is the Class 7 or 8 sales or the changes in the monthly sales.

4. Are the analytic methods and procedures employed technically appropriate and reasonable? Are the analytic methods and procedures applied appropriately, given the state of current science as you understand it? If yes, explain why. If not, explain why the methodology was not technically appropriate. Provide a description of each identified strength or weakness regarding technical appropriateness. Please distinguish between cases involving reasonable disagreement in methodology as opposed to cases where you conclude that any analytic methods and procedures in the draft report involve specific technical errors.

All reviewers agreed that the analytic methods and procedures employed are technically appropriate and reasonable. Dr. Christy Zhōu noted the reasons were explained in her comments under Charge Question #2 (see above). Dr. Holguín-Veras elaborated that the approach involving the use of differencing to remove autocorrelation in the time-series data and then using OLS (ordinary least squares) regression to conduct the analyses is a practical and acceptable technique. He also stated that it is appropriate to use OLS to get a general idea about the existence of pre-buy and low-buy behaviors and to estimate market-level direct elasticities.

Regarding the test for unit roots (i.e., systematic patterns that are unpredictable), Dr. Regan made two primary points: 1) the execution of the ADF test is appropriate and clearly explained and 2) the addition of the KPSS test and explanation of its meaning is also very helpful (also included above under Charge Question #3). Dr. Regan also commented that the results are as expected in some cases. She noted that, as an example, the causes for increases or decreases in purchases of Class 7 and 8 trucks (which carry goods exclusively) are quite different from those of Class 6 vehicles (which vary considerably by vocation).

Concerns

Dr. Holguín-Veras emphasized that cross-elasticities may only be estimated if and only if there are suitable data on prices and other key factors (cf. Dr. Holguín-Veras's detailed comments above under Charge Question #2).

Dr. Joann Zhou expressed concerns about the time period selected for pre-buy in the ERG draft report. She indicated it is not clear why 12 months was chosen as the analysis horizon (Section 3.3, page 51) in this study and questioned whether 12 months is the standard study period for pre-buy analysis. Dr. Joann Zhou indicated it would be helpful to provide more detailed context in the report by explaining the typical periods considered for pre-buy and low-buy analysis.

With respect to Section 4.4.2, Dr. Regan commented that it might helpful if a sentence were added to explain the positive beta coefficient for the 1-month period post-regulation. She guessed that these were pre-ordered vehicles that for some reason did not arrive until the first month after the regulation was in place. Dr. Regan believed that perhaps the sales were therefore not even governed by the new regulations. Furthermore, regarding Section 4.4.2, she noted the 6-month period after the 2004 regulation is actually months 2 through 6, not 1 through 6.

Dr. Holguín-Veras expressed concerns about the use of "visual inspection" (page 43, last paragraph) because that is not a formal method to assess regime shifts. He stated that if this analysis is not supported by statistical tests, then it must be removed.

Dr. Joann Zhou questioned the approach for the oil price in the ERG draft report. More specifically, she expressed concerns that it is not clear whether a monthly or annual oil price was used in the analysis. The reviewer suggested that if a monthly oil price was used, then it may be helpful to conduct the analysis using the average oil price over a few months (e.g., 4 through 5 months).

Dr. Holguín-Veras pointed to the top two lines on page 50 in the ERG draft report and stated that using the log differences imposes a functional form with constant elasticities. He stated this is a very strong assumption because in most cases elasticities are variable (i.e., as a function of price and other variables).

Finally, Dr. Joann Zhou expressed concerns about whether the effect due to the recession was considered when analyzing the impact of the 2007 regulations (pages 60 and 61) in the ERG draft report. She noted that the recession was mentioned earlier in the ERG draft report when discussing the sales trend. Dr. Zhou emphasized, however, that it is not clear whether the effect due to the recession was controlled for in the analysis.

5. Are the results and conclusions of the analysis in the draft report presented in appropriate ways? Were the conclusions in the draft report reasonably drawn? Do the conclusions follow logically from the results of the analytic methods and procedures?

The reviewers provided a range of comments about whether the results and conclusions of the analysis in the ERG draft report are appropriate.

- Dr. Holguín-Veras commented that the report provided, with appropriate caveats, defensible conclusions about pre-buy and low-buy effects. In contrast, Dr. Holguín-Veras emphasized that the conclusions presented in the report regarding class-switching and elasticities are very difficult to defend.

- Dr. Regan stated that the conclusions followed logically from the analysis. She commented that the conclusion that pre-buy and low-buy behavior reduces the effectiveness of regulations, but not by much, seems well grounded in the analysis.
- Dr. Christy Zhōu commented that the results are presented appropriately but provided several suggestions to improve the clarity of the results.
- Dr. Joann Zhou pointed out a conclusion about energy-efficient technologies in HDVs that seems contradictive.

Estimation of Class-Switching

Dr. Holguín-Veras stated that attempting to estimate class-switching without data that characterize the performance of the vehicles in the classes in question is simply not possible.

With respect to Section 4.5, Class Shifting, Dr. Holguín-Veras referred to comments provided under Charge Question #2 (see above) about numerous reasons that this section of the ERG draft report is problematic, including that the analysis/theoretical framework is inadequate and the variables used cannot properly explain the phenomenon, among others. He emphasized that the results for class-switching in the ERG draft report are not conceptually valid.

Finally, Dr. Holguín-Veras noted that the ERG draft report seemed to focus on the switch involving Classes 7 and 8. He asked whether a switch involving Classes 8 and 9 was considered, or a switch involving three or more classes, during the analyses conducted for this study.

Estimation of Elasticities

Dr. Holguín-Veras stated that the data in this study do not support a solid estimation of elasticities. He commented further that the absolute values of the estimated elasticities (0.558 to 2.347) in the ERG draft report are simply too high to be credible. Dr. Holguín-Veras provided a detailed explanation for why the estimated elasticities are not credible.

Furthermore, Dr. Holguín-Veras expressed concerns that the estimated cross-elasticities are not credible. He noted that the results for cross-elasticities, which were found to range between 0.681 and 1.712, should be smaller than the corresponding direct elasticities. He commented that the result in the ERG draft report where cross-elasticities have the same order of magnitude as the corresponding direct elasticities is not conceptually valid.

Under Charge Question #7 (see below), Dr. Christy Zhōu recommended "toning down" Section 4.7 and explained it is not the strongest part of the ERG draft report because of all the additional assumptions needed for computing price changes for the elasticity.

Suggestions to Improve Clarity

Dr. Christy Zhōu stated that because Equation 4 is the main equation, and Figures 14 and 15 are the main two figures, the report should at least present the regression table of Equation 4 in the same manner that it presents Table 13 for the equation on page 65.

Dr. Zhōu expressed concerns about Figures 14 through 23 and Figures 25 through 28, which appear to plot the coefficients of seasonality dummies on top of the pre-buy and post-buy dummies, that is, $\hat{\beta}_{1,m} + \hat{\beta}_4$ before the new regulation year and $\hat{\beta}_{1,m} + \hat{\beta}_5$ after the regulation is introduced. She pointed out that the ERG draft report only said "these models show … (Figure 14)" without informing the reader explicitly what was plotted in those figures. Dr. Zhōu recommended stating at least once what those figures plot, and then the rest of the figures would be self-explanatory.

Dr. Regan pointed to a statement in the ERG draft report that makes sense but would be clearer with a second sentence:

> In the case of the 2010 regulations, significant pre-buy and low-buy periods partially cancel one another out, though the period of significance was longer and larger for the pre-buy. (from page 78 of the ERG draft report)

She suggested adding an explanation in the report that this statement means the pre-buying before regulation and reduced purchases post-regulation are on the same scale, and together they reduce the effectiveness of the regulation. Dr. Regan clarified that the reason for this suggested additional explanation was that the first statement alone seems to suggest that the impacts cancel each other out while the impacts are additive.

Dr. Holguín-Veras questioned the notation used in the equations. Overall, he expressed concerns that the vast majority of the equations in the ERG draft report seem to be underspecified. As an example, Dr. Holguín-Veras suggested clarifying whether alpha and beta are vectors of parameters or single parameters. He also provided other specific comments about the notation for Equation 2 and Equation 3.

Section 4.4

Dr. Holguín-Veras provided specific comments about Section 4.4, stating it is not appropriate to use general statements without discussion and without showing the parameter values and their statistics to allow the reader to ensure that the results are conceptually valid and statistically significant. He also argued against using informal statements (e.g., "Model results for Class 7 show visual evidence …") and emphasized that the report should support such conclusions with statistical tests.

Energy-Efficient Technologies in HDVs

Dr. Joann Zhou pointed out the following conclusion for the 2014 regulations:

> This pre-buy effect is short-lived, which is intuitive as the 2014 Phase I regulations increased capital costs, but also offered improved fuel economy, thereby reducing operating costs. (from page 62 of the ERG draft report)

She asked whether this study found similar effects for the other regulations. She commented that if this conclusion is true, that would imply energy-efficient technologies in HDVs could be cost-effective for fleet operators. Dr. Zhou stated, however, that expert consensus is that HDV purchases are not fuel-cost sensitive and observed that this study indicates that as well. Dr. Zhou stated that it seems this conclusion on page 62 of the ERG draft report might be contradictive.

Dr. Zhou also noted that Table 3 does not show the expected cost impact of the 2014 regulations. She again commented it would be helpful to include a brief description of each studied regulation and their impacts on vehicle ownership cost (vehicle, operation, maintenance).

6. Are the selected figures, tables, and equations well-chosen and constructed to assist the reader in understanding the approach, analytic methods and procedures, results, and conclusions? If yes, explain why. If not, explain how the figures, tables, and equations could be improved to describe the approach, analytic methods and procedures, results, and conclusions more clearly in the report.

The reviewers provided a range of comments about the figures, tables, and equations in the ERG draft report. Dr. Regan stated simply that the figures, tables, and equations were all well chosen. Dr. Christy Zhōu commented that most of the tables and figures are clearly presented but recommended including confidence intervals in Figures 14 through 23 and Figures 25 through 28 to improve the clarity of the results. She also provided extensive comments about equations used in the ERG draft report under other charge questions (see above under Charge Question #2 and Charge Question #3). Dr. Joann Zhou provided specific suggestions for adding text in the report to improve the reader's ability to understand Figure 8 and Figures 18 through 23.

Finally, Dr. Holguín-Veras criticized the ERG draft report as being unnecessarily long, repetitive, with illegible figures, and lacking technical details about the models discussed. He provided the following suggestions to improve the report:

1) Increase the size of figures to improve readability.
2) Include all the statistics of the models discussed.
3) Summarize the results in tables (with all relevant statistics), instead of what this reviewer described as ERG's copying/pasting/adjusting the text to fit the results.
4) Remove all discussions of not statistically significant and not conceptually valid results.

7. Are there any other issues or concerns with the validity or scientific/technical merit of this report?

Two reviewers commented about the literature review in the ERG draft report with conflicting responses. Dr. Joann Zhou generally supported the literature review, and Dr. Holguín-Veras criticized the literature review.

- Dr. Zhou suggested including a short description of any literature available on the energy and emissions impact of pre-buy and low-buy behaviors. Under Charge Question #8, she commented that the literature review does a good job of summarizing the state of the art. Dr. Zhou also provided several specific comments about statements in the ERG draft report that seem inconsistent or incomplete.
- Dr. Holguín-Veras stated the literature review is very weak, particularly on topics directly relevant to class-switching. This reviewer stated those concerns could be addressed by 1) expanding the literature review to include a broader discussion of freight mode choice and freight vehicle choice and 2) discussing implications of the chief findings from the literature review for research conducted for the ERG draft report.

Drs. Regan and Christy Zhōu had no other issues or concerns with the validity or scientific/technical merit of the ERG draft report. Dr. Zhōu, however, recommended "toning down" Section 4.7 and explained it is not the strongest part of the ERG draft report because of all the additional assumptions needed for computing price changes for the elasticity.

8. If you are aware of better methods, tools, and available research employed and documented elsewhere to estimate sales, pre-buy, and other such impacts for use in policy analysis, provide suggestions for how they might be used to improve this report and also provide the associated references.

Dr. Holguín-Veras concluded that disaggregate models and data are the best alternatives to study pre-buy, low-buy, class-switching, and direct or cross-elasticities and stated this approach is consistent with the behavior literature. He also stated that aggregate modeling cannot replace disaggregate techniques. Dr. Holguín-Veras believed that a multimethod research effort involving qualitative and quantitative disaggregate research techniques would produce significantly better results.

Drs. Regan and Christy Zhōu had no comments about better methods or tools or other available research. Dr. Joann Zhou was not aware of other literature not already cited in the ERG draft report.

4 Individual Peer Reviewers' Comments

This section provides the individual peer reviewers' comments, with the peer reviewers presented in alphabetical order.

4.1 Dr. José Holguín-Veras

External Letter Peer Review of ERG draft report: *Analysis of Heavy-Duty Vehicle Sales Impacts due to New Regulation*
NAME: Dr. José Holguín-Veras
AFFILIATION: William H. Hart Professor Department of Civil and Environmental Engineering School of Engineering Rensselaer Polytechnic Institute Jonsson Engineering Center Troy, NY 12180
DATE: December 20, 2020
RESPONSE TO CHARGE QUESTIONS
1. Does the overall presentation in the draft report describe the data and methods sufficiently to allow the reader to form a general view of the quality and validity of the analysis performed?
The report provides a solid description of the history of EPA regulations and the theories related to vehicle replacement, and a good general view of the work. My interpretation of the research reported is that it is an exploratory effort to assess the feasibility of using secondary data to detect and quantify pre-buy, low-buy, and class-switching behaviors. Such exploratory research efforts are worthy undertakings because, although success is far from guaranteed, if they succeed they add additional evidence that could support the policymaking process. I believe that EPA, USDOT, USDOE, and other regulatory agencies should undertake major efforts to understand the behavioral responses of the freight industry to environmental/ transportation/energy policy. It is not possible to effect positive change in a system whose behaviors are poorly understood by policy makers. I would like to urge all involved to redouble efforts to understand freight industry behaviors. In my view, this report is a good step in this direction.
2. Are the data sources and assumptions appropriate for the analysis conducted? If yes, explain why. If not, describe all issues identified regarding the validity of data sources and assumptions and provide suggestions and references for other available data that might be used to improve this analysis. As relevant, describe how the validity of data sources and assumptions could be more clearly described in the report.
I have various degrees of concerns about the data used to conduct the various analyses discussed in the report. The quantitative component of the report focuses on the: 1) Identification of pre-buy and low-buy behaviors: There is consensus in the behavior research community that aggregate data—like the one used in this report—are unable to identify the root behaviors at the core of transportation choice processes. However, if the

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NAME: Dr. José Holguín-Veras

objective of these analyses is exploratory, and only aimed at getting a general idea about pre-buy and low-buy effects, the analyses may be appropriate. In contrast, if the intent is to use the findings to support policy-making, further confirmatory research is strongly recommended.

2) Identification of "class-switching": In this case, the use of aggregate data is of doubtful utility to assess the extent of class switching for the simple reason that the data do not contain class-specific descriptors, e.g., cargo capacity and operational costs, that could be used as independent variables in the econometric models. As established by the literature on freight mode and vehicle choice (with root behaviors that are closely related to those in class-switching), the consensus position is that using disaggregate data is, by far, the best approach. See: https://www.nap.edu/catalog/25660/impacts-of-policy-induced-freight-modal-shifts (National Academies of Sciences, Engineering, and Medicine. 2019. *Impacts of Policy-Induced Freight Modal Shifts*. Washington, DC: The National Academies Press); and https://authors.elsevier.com/a/1cDs13Rd3urYEY (Holguín-Veras, J., et al. 2002. "Freight mode choice: Results from a nationwide qualitative and quantitative research effort." *Transportation Research Part A: Policy and Practice* 143: 78-120).
3) Estimation of direct- and cross-elasticities: Aggregate time-series data can indeed be used to estimate direct elasticities at the market level. However, the use of such data for the estimation of cross-elasticities is challenging in the best of circumstances because these effects cannot be easily captured by aggregate data. Moreover, in the absence of class-specific data about purchase prices and other descriptors of the vehicles in a class, estimating cross-elasticities is not possible.

In summary, the data sources are:

1) Appropriate to obtain a general idea of the existence of pre-buy and low-buy behaviors, and to quantify direct elasticities at the market level; and
2) Inappropriate for analyses of class-switching and estimation of cross-elasticities.

Additional comments:

1) Page 15, Section 2.3.1: The trucking companies that exercise pre-buy, low-buy, and class-switching are not in competitive markets. In these markets, rates are equal to marginal costs, and the carriers do not recover the fixed costs, and obviously cannot purchase new trucks. The companies that participate in pre-buy, low-buy, and class-switching behaviors are those that operate in markets where the companies have some pricing power. Owner-operators, intermodal-truck operators, and other small companies are not likely to do pre-buy, low-buy, or class-switching.
2) Page 16, Section 2.3.4: It should be made clear that pre-buy, low-buy, and class-switching (together with do-nothing) are alternative choices for company managers.

3. Is the description of the analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made in this analysis? If yes, explain why. If not, explain how the analytic methods and procedures could be more clearly described in the report.

In general terms the report is clearly written.

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NAME: Dr. José Holguín-Veras

Section 4 is the exception as it is repetitive and unnecessarily long (to a great extent because it discusses results that are not statistically significant and not conceptually valid). Section 4 is problematic in other respects as it does not contain the model statistics—such as t-values, R2, and F—that reviewers need to judge the validity of the results. In my view, this is unacceptable.

Limiting the discussion to the results that are statistically significant and conceptually valid; and adding a comprehensive appendix with the best models obtained and the corresponding statistics (even if these models are not statistically significant and conceptually valid); would lead to a more concise, readable, and useful document that will reassure readers that the work conducted has rigor.

Another issue to be addressed is the tendency to make informal statements such as this one from page 53:

> "Beta represents the "change in the percent change in Y for a one-unit 'change in the percent change' of X. The practical application of this coefficient is to consider it identical to the elasticity".

This statement is wrong from the mathematical point of view.

Additional comments:

1) Page 17, Section 2.3.5: This section conveys the impression that changes in freight mode choice are always forthcoming in response to price changes. In fact, shippers and receivers—who are the key decision makers in this matter—have considerable inertia, and decide on mode and vehicle changes after considering other factors, e.g., reliability. Freight mode choice does not change as easily as suggested in this section.
2) Page 30, Section 2.7: The review must be expanded to include papers and reports on vehicle choice.

4. Are the analytic methods and procedures employed technically appropriate and reasonable? Are the analytic methods and procedures applied appropriately, given the state of current science as you understand it? If yes, explain why. If not, explain why the methodology was not technically appropriate. Provide a description of each identified strength or weakness regarding technical appropriateness. Please distinguish between cases involving reasonable disagreement in methodology as opposed to cases where you conclude that any analytic methods and procedures in the draft report involve specific technical errors.

The approach used in the paper—entailing the use of differencing to remove autocorrelation in the time-series data and then use OLS to conduct the various analyses of interest—is a practical and acceptable technique.

As stated earlier in relation to my answers to Charge Question #2, it is appropriate to use OLS to get a general idea about the existence of pre-buy and low-buy behaviors and to estimate market-level direct elasticities. Cross-elasticities may only be estimated, if and only if, there are suitable data on prices and other key factors.

Other comments:

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1) Page 43, last paragraph: "Visual inspection" is not a formal method to assess regime shifts. If not supported by statistical tests, the analysis must be removed.
2) Page 50, top two lines: Using the log differences imposes a functional form with constant elasticities. This is a very strong assumption as in most cases elasticities are variable, i.e., as a function of price and other variables.

5. Are the results and conclusions of the analysis in the draft report presented in appropriate ways? Were the conclusions in the draft report reasonably drawn? Do the conclusions follow logically from the results of the analytic methods and procedures?

My conclusion is that the report provides, with appropriate caveats, defensible conclusions about pre-buy and low-buy effects. In contrast, the conclusions reached regarding class-switching and elasticities are very difficult to defend. As made clear in the literature, the estimation of econometric models that capture the essence of freight mode or vehicle choice is a complex undertaking in the best of circumstances. Attempting to estimate class-switching without data that characterize the performance of the vehicles in the classes in question, is simply not possible. My conclusion is that the data do not support a solid estimation of elasticities.

Moreover, the absolute values of the estimated elasticities (0.558 to 2.347) are simply too high to be credible. To explain why I believe this is the case, it is useful to mention that there are two primary mechanisms that could increase demand for truck services: (1) changes in the commodity flows between shippers and receivers, and (2) changes in the supply chains that transport these commodify flows.

It should be kept in mind that freight transportation activity is derived from the commodity flows traded among other economic sectors. Carriers do not create the demand, they simply transport the cargo. As a result, carriers would only increase fleet sizes if they are confident there will be a sustained increase in the demand for their services. While it is true that drastic reductions in transportation costs could indeed transform the structure of the economy and the associated commodity flows, this only happens in massive projects such as the Erie Canal, the transcontinental railroads, interstate highway system, or the UK-EU tunnel.

However, although commodity flows do not change much in response to small changes in transportation costs, supply chains are another matter. In response to changes in transportation costs of some importance, supply chains could react in multiple ways; from a complete restructuring of the network, to changes in shipment sizes, frequency of shipments, and the type of vehicles used. The latter changes (underlined) could be indeed triggered by changes in transportation costs. The reason is that businesses always try to minimize the total logistic costs, i.e., the summation of cost of transporting and storing the supplies. If transportation costs are low, in relation to the storage cost, the best policy is to reduce shipment size and increase the frequency of shipments (allowing the business to save storage costs). If transportation costs are high, the opposite happens. These tradeoffs are at the core of the Economic Order Quantity (EOQ) model. The applications of the EOQ model clearly indicate that the elasticity of the frequency of shipments (which is what determines the need for trucks) is inelastic.

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NAME: Dr. José Holguín-Veras

As an example, the table below from Holguín-Veras and Sánchez-Díaz (2016), shows the effect of an environmental charge of $5.86 for each delivery to commercial receivers of supplies. The table below shows the optimal number of deliveries that minimizes the total logistic costs considering the value of the space at the bottom of the third and fourth columns. As shown, an environmental charge of $5.86 increases the shipping cost from $30.00 to $35.86, i.e., 23.44%; and reduces the number of deliveries/day (or freight trip attraction) from 2.332 to 2.099, i.e., -9.99%. These results indicate that the direct elasticity of the number of deliveries is -0.18. If the number of deliveries is inelastic to an increase in transportation cost of 25%, it is extremely unlikely that a smaller increase in the purchase costs of trucks would lead to a more than proportional increase in the number of trucks purchased.

Table 1
Optimal ordering policies.

Description	Classic EOQ	Space-allocation EOQ (SA-EOQ)	SA-EOQ with receiver charge
Parameters			
π_P ($/ft^2/hour)	0.0000	0.8163	0.8163
ϕ (ft^2/ft^3)	0.1667	0.1667	0.1667
d_Q ($/ft^2/hour)	0.0204	0.0204	0.0204
C_o: Order cost ($/delivery)	$5.00	$5.00	$5.00
C_T: Transport cost ($/delivery)	$20.00	$20.00	$20.00
τ: Receiver charge ($/delivery)	–	–	$5.86
C_I: Inventory cost ($/ft^3/hour)	$0.20	$0.20	$0.20
Results			
Q: Optimal order size (ft^3)	56.469	36.754	40.835
T: Optimal cycle time (hours)	15.811	10.291	11.434
A_s: Storage area (ft^2)	9.412	6.126	6.806
Freight trip attraction, FTA, (trips/day)	1.518	2.332	2.099

(citation: Holguín-Veras, J. and I. Sánchez-Díaz. 2016. "Freight Demand Management and the Potential of Receiver-Led Consolidation Programs." *Transportation Research Part A* 84: 109-130.)

Elasticities larger than one imply that changes in the purchase prices of trucks (a tiny proportion of the cost of production of the goods transported) would translate into more-than-proportional changes in the numbers of trucks purchased. These results do not seem sensible, because the change in purchase prices is too small to have any influence in the demand for truck transportation.

Equally concerning are the results for cross-elasticities, which were found to range between 0.681 and 1.712. As amply established in the transportation literature on cross-elasticities, relative to each other, cross-elasticities ought to be smaller than the corresponding direct elasticities. The reason is simple: the cross-effect is less potent than the effect of the "own" price. In this case, however, they have the same order of magnitude. Regrettably, I only found one paper on vehicle choice that reported the cross-elasticities (Holguín-Veras 2002). The table below (the final results are surrounded by a blue rectangle) shows that, as expected, the cross-elasticities are generally much smaller than direct elasticities. The exception is cross-elasticity between the price of pickups (P) and the demand for (mid-size) trucks (T), i.e., 0.067, that is larger in absolute value than the direct elasticity (-0.036) and that, as noted in the 2002 paper, is an estimation error.

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Table 8. Elasticities Estimated from Heteroscedastic Extreme Value Model

Variable is in utility function of	Elasticities of cost in choice of P	T	S
	(a) Simple average of individual elasticities		
Pickups (P)	−0.027	0.095	0.007
Trucks (T)	0.087	−0.079	0.007
Semitrailers (S)	12.353	0.549	−4.121
	(b) Weighted average of individual elasticities		
Pickups (P)	−0.036	0.067	0.007
Trucks (T)	0.032	−0.065	0.007
Semitrailers (S)	0.013	0.120	−0.373

(citation: Holguín-Veras, J. 2002. "Revealed Preference Analysis of Commercial Vehicle Choice Process." *Journal of Transportation Engineering* 128(4): 336-346).

Needless to say, the authors' result in the ERG draft report where cross-elasticities have the same order of magnitude as the corresponding direct elasticities is not conceptually valid.

Additional comments:

1) Section 4.4:
   a) The authors should not use statements such as "the coefficients for other explanatory variables are robust to model specification… and have been omitted in favor of discussion …" This is not appropriate. To start, what is the meaning of "robust"? They must show the parameter values, and their statistics, to ensure that they are conceptually valid and statistically significant.
   b) Statements such as "Model results for Class 7 show visual evidence…" are too informal for a report of this nature. The authors need to support such conclusions with statistical tests.
   c) Figures are too small.
   d) Figure 21, by the authors' admission, shows results that are not statistically significant. In cases like that, it is better to simply add a note indicating that these results were not significant.

2) Notation used in equations:
   a) The vast majority of the equations in the report seem to be under-specified. Are alpha and beta vectors of parameters? Or single parameters? Please clarify.
   b) In Equation 3, is beta1 constant for all months t?
   c) Is the variable "Month" in Equation 2, a time index that start with 1… until the number of the last time period? Or is it a set of binary variables for each month?

3) Section 4.5: Class Shifting
   a) As explained in my answer to Charge Question #2, this section is problematic for numerous reasons, the analysis/theory framework is inadequate; the variables used cannot properly explain the phenomenon, among others. Moreover, the results are not conceptually valid.
   b) The report seems to focus on the switch involving classes 7 and 8. Was a switch involving classes 8 and 9 considered? Or a switch involving three or more classes?

External Letter Peer Review of ERG draft report: *Analysis of Heavy-Duty Vehicle Sales Impacts due to New Regulation*
NAME: Dr. José Holguín-Veras
6. Are the selected figures, tables, and equations well-chosen and constructed to assist the reader in understanding the approach, analytic methods and procedures, results, and conclusions? If yes, explain why. If not, explain how the figures, tables, and equations could be improved to describe the approach, analytic methods and procedures, results, and conclusions more clearly in the report.
In its current version, the report is unnecessarily long, repetitive, with illegible figures, and lacking technical details about the models discussed. There are numerous ways to improve it. For instance: 1) Increase the size of figures to make them readable. In most cases, the font size seems to be 5 or less. 2) Include all the statistics of the models discussed. 3) Instead of copying / pasting / adjusting the text to fit the results, summarize the results in tables (with all relevant statistics). 4) The authors discuss results that are not statistically significant, and even results that are not conceptually valid (that the authors struggle to explain). I suggest removing all discussions of non-significant and not conceptually valid results. A focused discussion of statistically significant and conceptually valid results would cut the size of the document by at least 50%.
7. Are there any other issues or concerns with the validity or scientific/technical merit of this report?
The literature review is very weak, particularly on topics directly relevant to class-switching. The authors must expand the literature review to include a broader discussion of freight mode choice and freight vehicle choice, and the implications of the chief findings from the literature on the research reported in the document.
8. If you are aware of better methods, tools, and available research employed and documented elsewhere to estimate sales, pre-buy, and other such impacts for use in policy analysis, provide suggestions for how they might be used to improve this report and also provide the associated references.
My conclusion, which is consistent with the behavior literature, is that disaggregate models and data are the best alternatives to study pre-buy, low-buy, class-switching, and direct or cross-elasticities. While I understand the desire to explore the use of secondary data to study the effects of public policy, the hard reality is that aggregate modeling simply cannot replace the use of disaggregate techniques. I believe that a multi-method research effort involving qualitative and quantitative disaggregate research techniques is bound to produce significantly better results. This could encompass in-depth-interviews with a selection of trucking companies, maybe focus groups, revealed and stated preference surveys, and econometric modeling.

4.2 Dr. Amelia C. Regan

External Letter Peer Review of ERG draft report: *Analysis of Heavy-Duty Vehicle Sales Impacts due to New Regulation*

NAME: Dr. Amelia C. Regan

AFFILIATION:
Professor of Computer Science and Transportation Systems Engineering
Department of Computer Science and Institute of Transportation Studies
University of California, Irvine
Bren Hall 4068
Irvine, CA 92697-3435

DATE: November 30, 2020

RESPONSE TO CHARGE QUESTIONS

1. Does the overall presentation in the draft report describe the data and methods sufficiently to allow the reader to form a general view of the quality and validity of the analysis performed?

The overall presentation is exceptionally clear.

For example, I had to read Section 2.5.2 a couple of times before I could understand it, but this was not a fault of the authors – there are some counter-intuitive and challenging ideas being discussed. The discussion of when and if customers will accept surcharges that (sometimes more than) make up for the cost of environmental compliance is a very important one that is often overlooked.

Here is one exception: On page 33 the following paragraph appears:

> "The expected incremental costs of an HDV purchased in the first year of a regulation may be considerably higher than those of a vehicle purchased later on in the regulation cycle (e.g. expected incremental costs of an HDV purchased in 2004 vs. 2009, or purchased in 2007 vs. 2012, as shown as shown by the difference in near-term and long-term costs."

Table 3 has the column heading, Estimated/Anticipated Costs, but the word expected shows up in the text of this paragraph on page 33. Is expected incremental = estimated? Or = anticipated? Or neither? Is this expected as in probabilistic expectation? Sorry if my concern appears silly, but this section of the text is difficult to follow.

2. Are the data sources and assumptions appropriate for the analysis conducted? If yes, explain why. If not, describe all issues identified regarding the validity of data sources and assumptions and provide suggestions and references for other available data that might be used to improve this analysis. As relevant, describe how the validity of data sources and assumptions could be more clearly described in the report.

The data sources seem very appropriate and the explanation of each is clear. Section 3.1.7 is very useful to the reader because it addresses the question "what other data might have been useful" before the reader can even get to it.

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NAME: Dr. Amelia C. Regan
I am a bit surprised that the second item listed "All Employees, Truck Transportation" was neither significant nor helpful, but the discussion and graphs on page 48 make very clear why that is so.
3. Is the description of the analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made in this analysis? If yes, explain why. If not, explain how the analytic methods and procedures could be more clearly described in the report.
Section 3.1 is exceptionally clear. The information presented mainly deals with the data. Section 3.2 is discussed in the next question. As an educated reader, but not an econometrician, I found Section 3.3 and 3.4 very clear and illuminating. I find it especially helpful that key equations are numbered and intermediate (explanatory) ones are not.
4. Are the analytic methods and procedures employed technically appropriate and reasonable? Are the analytic methods and procedures applied appropriately, given the state of current science as you understand it? If yes, explain why. If not, explain why the methodology was not technically appropriate. Provide a description of each identified strength or weakness regarding technical appropriateness. Please distinguish between cases involving reasonable disagreement in methodology as opposed to cases where you conclude that any analytic methods and procedures in the draft report involve specific technical errors.
The methods seem appropriate. I'll admit that I had to refresh my memory about test for unit roots (systematic patterns that are unpredictable), but execution of the ADF test is appropriate and clearly explained. The addition of the KPSS test and explanation of its meaning was also very helpful. The results are also as expected in some cases. For example, the causes for increases or decreases in purchases of class 7 and 8 trucks (which carry goods exclusively) are quite different from those of class 6 vehicles which vary considerably by vocation. In Section 4.4.2, it might help if a sentence is added to explain the positive beta coefficient for one-month period post-regulation. I can guess that these were pre-ordered vehicles that for some reason did not arrive until the first month after the regulation was in place. Perhaps the sales were therefore not even governed by the new regulations? The six-month period post the 2004 regulation is actually months 2-6, not 1-6.
5. Are the results and conclusions of the analysis in the draft report presented in appropriate ways? Were the conclusions in the draft report reasonably drawn? Do the conclusions follow logically from the results of the analytic methods and procedures?
The conclusions do follow logically from the analysis. The conclusion that pre-buy and low-buy behavior reduce the effectiveness of regulations but not by much seems to be well grounded in the analysis. There is a statement on page 78 that makes sense but would clearer with a second sentence.

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NAME: Dr. Amelia C. Regan
"In the case of the 2010 regulations, significant pre-buy and low-buy periods partially cancel one another out, though the period of significance was longer and larger for the pre-buy." MY SUGGESTION: By that we mean that the pre-buying before regulation and reduced purchases post-regulation are on the same scale. Together they reduce the effectiveness of the regulation. The reason I make this suggestion is that the first statement alone seems to suggest that the impacts cancel each other out while the impacts are additive.
6. Are the selected figures, tables, and equations well-chosen and constructed to assist the reader in understanding the approach, analytic methods and procedures, results, and conclusions? If yes, explain why. If not, explain how the figures, tables, and equations could be improved to describe the approach, analytic methods and procedures, results, and conclusions more clearly in the report.
The figures, tables and equations are all well-chosen.
7. Are there any other issues or concerns with the validity or scientific/technical merit of this report?
I have no issues or concerns with the validity or scientific/technical merit of this report.
8. If you are aware of better methods, tools, and available research employed and documented elsewhere to estimate sales, pre-buy, and other such impacts for use in policy analysis, provide suggestions for how they might be used to improve this report and also provide the associated references.
I am not aware of better methods to do this analysis.

4.3 Dr. Yìchén (Christy) Zhōu

External Letter Peer Review of ERG draft report: *Analysis of Heavy-Duty Vehicle Sales Impacts due to New Regulation*

NAME: Dr. Yìchén (Christy) Zhōu

AFFILIATION:
Assistant Professor of Economics
Clemson University
320M Wilbur O. and Ann Powers Hall
Clemson, SC 29634

DATE: November 29, 2020

RESPONSE TO CHARGE QUESTIONS

1. Does the overall presentation in the draft report describe the data and methods sufficiently to allow the reader to form a general view of the quality and validity of the analysis performed?

The overall presentation in the draft report does a sufficient job of describing the data and methods and allowing the reader to form a general view of the quality and the validity of the analysis performed.

The goal of the report is to analyze how new emission standards for heavy-duty vehicle (HDV) affect HDV sales in the short run immediately before and after the time when the new standards went into effect. The analysis includes three waves of new regulations that went into effect in 2007, 2010, and 2014 that target PM and NOx emissions rates. All my comments under the subsequent charge questions evaluate how well the authors achieve this main goal in various aspects.

2. Are the data sources and assumptions appropriate for the analysis conducted? If yes, explain why. If not, describe all issues identified regarding the validity of data sources and assumptions and provide suggestions and references for other available data that might be used to improve this analysis. As relevant, describe how the validity of data sources and assumptions could be more clearly described in the report.

The data sources and assumptions are appropriate for the analysis conducted, given the constraints that the authors have in terms of data access; they are not the most ideal (perfect) for the analysis but the data sets and the assumptions are still useful to understand the effect of regulation on HDV sales in the short run.

The ideal dataset to answer this question is transaction-level data or very-fine registration level data, which are very costly to obtain. The second-best dataset to answer this question are datasets that are slightly more aggregate than the above one. For example, sales could be aggregated to make-by-class-by-year level (better at the state level but okay if at the national level), or to make-by-class-by-buyer-type-by-year level. From my own experience, it is not always easy to obtain datasets at this level.

The dataset the authors end up with is at the level of class-by-month. It is appropriate with one shortcoming and one advantage. The advantage is the authors obtain monthly data, which is limited to pin down the short-run effect. Getting the monthly data is an important and successful first step for the authors. The shortcoming is the data set has a lack of cross-sectional variation since they are aggregated to class (class 7, 8, and 9) which prevents the authors to exploit cross-sectional variation that is typically used in panel data (either in a Difference-in-Difference model, or a fixed-effect model, or an event-study model with fixed effects). Because of the constraint of the data sources, the authors choose to exploit temporal variation, which I think is appropriate to estimate the short-run effect of emission standards on sales, as specified in their main Equation (4).

The authors did not explicitly state the assumptions that allow them to identify the parameters β_4 and β_5 (and the jump in the parameters before and after the introduction of the new standards). However, given the authors know how to specify Equation (4), the authors implicitly assume the following – "the factors that make sales to change from the months $t - m$ leading up to the standards and the months $t + m$ immediately after the standards are (i) solely due to the introduction of new standards and (ii) uncorrelated to other potential confounding factors, after removing factors from the seasonality and covariates." Aka, conditional seasonality and covariates that the authors control, the "*pre buy*" in $t - m$ and "*low buy*" in $t + m$ are not driven by factors other than the new regulation.

This is usually a weak assumption to defend if the data is more disaggregated (so that the authors can use fixed effects to remove unobservables constant within each cross-sectional unit). Given the lack of cross-sectional variation, this

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NAME: Dr. Yìchén (Christy) Zhōu

assumption becomes a slightly stronger assumption. To make the identifying assumption appropriate, the authors further include a few covariates to control for factors correlated to potential demand and supply shifters: GDP, Brent oil, total imports and exports, and consumer sentiment. The authors have done the best they can to control for potential bias given the data constraint.

In the case when the assumption fails, it is more likely that the authors underestimate the effects of "pre buy" and "low buy" rather than exaggerate the effects. For example, the empirical strategy laid out in Equation (4) will pick up all the increases in the sales in the aftermath of the new regulation and the authors find a negative effect. For one example, to mitigate the impact, in months after the new regulation, buyers can still purchase older model years remaining in the stock, if the carmakers still have any. In this case, the "low buy" effect is underestimated. For another example, to mitigate the impact after the regulation, sellers can manipulate the price point. Carmakers can lower the price (what I mean is lower the mark-up rate so that the price paid in the market is lower than the price point if the carmakers had kept the same mark-up rate). The lower price would lead to more sales, in which case, the "low buy" effect is underestimated. Or, in the third case, to reduce the within-make competition in $t - m$ versus $t + m$, the carmakers can slightly increase prices in $t - m$ so that their sales in $t + m$ will not decrease too much (of course, carmakers have to balance potential gain in $t + m$ to trade off the loss in $t - m$). If this happens, the "pre buy" is underestimated.

In summary, the identifying assumption (that the authors implicitly impose by specifying Equation (4)) rules out / assumes away any strategic behavior HDV sellers or buyers may have done to reduce the impact of the regulation other than the main channel "pre buy" and "low buy". In the worst case, when the identifying assumption falls apart, we should interpret the estimates of "pre buy" and "low buy" as conservative estimates.

To improve the validity of the assumption, first, I think the authors can benefit from stating it explicitly after introducing Equation (4) on page 58. Also, as I will mention under Charge Questions #3 and #4, after introducing Equation (4), the authors would benefit from stating the specific controls log(Xt) included in the Equation, which does not appear until page 66. The authors should explain log(Xt) right after Equation (4) before explicitly laying out the identifying assumption. Without introducing which variables go into the Equation, it will be unclear what β_4 and β_5 pick up. Third, the authors should discuss in which directions and in which cases their estimates are biased when their assumption does not hold up. I think the estimates can be conservative for the reasons that I stated above if their assumption does not hold up. The authors should lay out all possibilities that they believe might be possible. For example, if the authors consider it is also possible that unobservables can exaggerate the "pre buy" and "low buy" effects (rather than dampen the effects), they should lay out the reasons and explain potential omitted variables and channels that make that happen.

3. Is the description of the analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made in this analysis? If yes, explain why. If not, explain how the analytic methods and procedures could be more clearly described in the report.

The description of the analytic methods and procedures is clear and detailed enough to allow the readers to develop an adequate understanding of the steps taken and assumptions made in this analysis.

First, I have a few minor suggestions on a few specific equations.

As I stated under Charge Question #2, the authors can benefit by explaining specific variables that go into Equation (4) on page 58. In the current version, that does not appear until page 66 in the regression table.

Also, the month variable is usually called the "month-of-the-year dummy variables" in a regression like this. Stating $month_t$ as a month will confuse readers who imagine the month as 1,2,…12; 13,14….24; 25…, which is typical when you have more than a year.

The authors may want to call $\Delta logClassi_t$ as $\Delta logSales_t$. Usually, the class is a dummy, so readers will be confused. What the authors mean are sales. Given that the authors estimate Equation (4) separately for each class, $\Delta logSales_t$ is sufficient and there is no need for $\Delta logSales_{it}$. The authors should state Equation (4) is estimated separately for

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each class before getting into Section 4.4.1; otherwise, readers will wonder why the authors do not have a dummy for each class on the right-hand-side.

Similarly, for the Equation on page 65, it is better to call "log Class 8" as "sales". It can be $\Delta logSales_{8,t}$ or another way depending on the authors' preference. Also, it may be helpful to add an equation number.

In Table 13 for the Equation laid out on page 65, it appears that pre and post are "pre 2 months" and "post 2 months" which makes Equation (4) unclear in comparison. The authors stated on page 58 that they group months together in the pre and post dummies. The authors should clearly state the number of months they group in their baseline estimates. (If they do robustness and adjust the bandwidth, they can explain that later.)

Second, the authors can benefit from using more consistent descriptions. The authors change how they describe their model: in the introduction, the authors say they use time-series methods, then in the main analysis, the authors say they use difference-in-differences. Then when the authors show the Equation and the results, it appears to me the authors use an event-study model since the presentation of $\beta_4 Pre_{t-m}$ usually are written as dummies (in plural) before an event and $\beta_5 Pre_{t+m}$ as dummies afterwards. It is not until Table 13, where I realize the authors have one pre dummy and one post dummy. Regarding the description of the methodology, (i) the authors should not call the model as diff-in-diff since there is no control group (a cross-sectional control group); the authors do implicitly use no-regulation years for the same class as a control to identify β_4 and β_5 and the authors would better state that after Equation (4) when discussing identifying assumptions. The authors do have first-difference, so when explaining variables in Equation (4) right after Equation (4), the authors should tell/remind us the left-hand-side variable is a detrended first-difference variable of sales.

4. Are the analytic methods and procedures employed technically appropriate and reasonable? Are the analytic methods and procedures applied appropriately, given the state of current science as you understand it? If yes, explain why. If not, explain why the methodology was not technically appropriate. Provide a description of each identified strength or weakness regarding technical appropriateness. Please distinguish between cases involving reasonable disagreement in methodology as opposed to cases where you conclude that any analytic methods and procedures in the draft report involve specific technical errors.

The analytic methods and procedures are appropriate and reasonable. As for the reason, I have stated that under Charge Question #2 as well.

5. Are the results and conclusions of the analysis in the draft report presented in appropriate ways? Were the conclusions in the draft report reasonably drawn? Do the conclusions follow logically from the results of the analytic methods and procedures?

The results are presented appropriately. The authors can improve the clarity of the results as follows:

First, for Figures 14-23, and Figures 25-28, it appears the authors plot the coefficients of seasonality dummies on top of the "pre buy" and "post buy" dummies, aka $\hat{\beta}_{1,m} + \hat{\beta}_4$ before the new regulation year, and $\hat{\beta}_{1,m} + \hat{\beta}_5$ after the regulation is introduced. However, the authors only say "these models show … (Figure 14)" without informing me explicitly what are plotted in those figures. I recommend the authors state what they plot at least once. Then the rest of the figures would be self-explanatory.

Second, given Equation (4) is the main equation, and Figures 14-15 are the main two figures, the authors should at least present the regression table of Equation (4) just like they have presented Table 13 for the Equation on page 65.

6. Are the selected figures, tables, and equations well-chosen and constructed to assist the reader in understanding the approach, analytic methods and procedures, results, and conclusions? If yes, explain why. If not, explain how the figures, tables, and equations could be improved to describe the approach, analytic methods and procedures, results, and conclusions more clearly in the report.

Most tables and figures are clearly presented. The authors can improve the clarity of the results as follows:

Given that Figures 14-23, and Figures 25-28, plot coefficients, these figures should include confidence intervals.

7. Are there any other issues or concerns with the validity or scientific/technical merit of this report?

No further serious issues.

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NAME: Dr. Yìchén (Christy) Zhōu
Section 4.7 is not the strongest part of the report because of all the additional assumptions needed for computing price changes for the elasticity. It is reasonable given that Section 4.4 to 4.6 are the main results. I recommend toning down Section 4.7 a little bit as potential implications or the suggestive outcome or something along that line.
8. If you are aware of better methods, tools, and available research employed and documented elsewhere to estimate sales, pre-buy, and other such impacts for use in policy analysis, provide suggestions for how they might be used to improve this report and also provide the associated references.
No further comments.

4.4 Dr. Yan (Joann) Zhou

External Letter Peer Review of ERG draft report: *Analysis of Heavy-Duty Vehicle Sales Impacts due to New Regulation*

NAME: Dr. Yan (Joann) Zhou

AFFILIATION:
Group Leader, Mobility and Deployment
Systems Assessment Center
Energy Systems Division
Argonne National Laboratory
9700 S. Cass Ave, Building 362, E337
Lemont, IL 60439

DATE: November 25, 2020

RESPONSE TO CHARGE QUESTIONS

1. Does the overall presentation in the draft report describe the data and methods sufficiently to allow the reader to form a general view of the quality and validity of the analysis performed?

Yes. However, I would suggest changing the "abstract" to "Executive Summary" and move some of the contents from the "Conclusions" to "Summary". For people who do not have time to read the 80-page report, they can still comprehend a full picture of the data and methodologies used, as well as the key take-ways from this study.

Secondly, I would suggest clarifying in the "Introduction" and "Summary" that although the HDV regulation covers from class 2b to class 8, this study focus on class 6-8 due to data limitations.

2. Are the data sources and assumptions appropriate for the analysis conducted? If yes, explain why. If not, describe all issues identified regarding the validity of data sources and assumptions and provide suggestions and references for other available data that might be used to improve this analysis. As relevant, describe how the validity of data sources and assumptions could be more clearly described in the report.

Overall, the data sources and assumptions are appropriate.

On the vehicle sales, have you compared the sales data with registration data to see whether they are aligned (after removing the time gap between sales and registration)?

In the beginning of Section 3 Data and Methodology, I would suggest adding a table to show all the data considered in the analysis and modeling. The suggested table could be similar to the following (as an example).

Variable	Models (in which the data was used)	Unit	Source	Notes

Table 3 and Section 4.7: More description about how these costs were estimated and used in this analysis would be appreciated. My understanding is that some of the cost estimates are for vehicle

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NAME: Dr. Yan (Joann) Zhou

cost, while others include operation. In the analysis of elasticity, have you considered just the vehicle purchase cost or vehicle purchase cost plus operation cost?
"Anticipated regulatory costs are discussed in Section 2.8. As shown in Table 3, EPA estimated the 2004 regulations (implemented 1 October 2002) would increase the net present value of HDV diesel costs by $1,004 (2019$) and the 2007 regulations would increase total costs (capital plus operations and maintenance) by $10,811, and the 2010 regulations by $9,868."

Page 38 Section 3.1.1: Please cite the reference for the vehicle sales in the content, not just on the figure.

3. Is the description of the analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made in this analysis? If yes, explain why. If not, explain how the analytic methods and procedures could be more clearly described in the report.

Overall, the description of the analytic methods and procedures is clear and detailed enough for me to understand what has been done.

First, an overall summary of all the regulations (e.g., 2004, 2007 and 2010…) studied would be helpful to ensure the audiences understand the major policies implied by each of them. Table 3 did show the cost estimates of each regulation. However, a discussion of the major emission standards, and how that could change the vehicle cost but also reduce the operation cost would be very helpful to put some of the results into context.

Page 54 Section 4.1 Figure 3 shows that only Class 8 has highest sales during Oct-Dec.
"Boxplots of the data grouped by month indicate that sales follow seasonal patterns with January and February showing the fewest sales, and October – December showing the highest sales."

Page 55 Section 4.2: I am confused about what exactly is the dependent variable? The Class 7 or 8 sales, or the changes in the monthly sales?

4. Are the analytic methods and procedures employed technically appropriate and reasonable? Are the analytic methods and procedures applied appropriately, given the state of current science as you understand it? If yes, explain why. If not, explain why the methodology was not technically appropriate. Provide a description of each identified strength or weakness regarding technical appropriateness. Please distinguish between cases involving reasonable disagreement in methodology as opposed to cases where you conclude that any analytic methods and procedures in the draft report involve specific technical errors.

Yes, the analytic methods and procedures employed are technically appropriate and reasonable.

Page 51 Section 3.3: Why do you choose 12 months as the analysis horizon? Is this the standard study period for pre-buy? What are the typical periods considered for pre-buy and low-buy analysis?
"…two combined months prior to regulation, all regulations taken together, and so on until Pre_{12} which would include all 12 months prior to the regulation."

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NAME: Dr. Yan (Joann) Zhou
Page 60-61: Was the effect due to recession considered when analyzing the impact of 2007 regulations? The recession was mentioned earlier when discussing the sales trend. However, it was not clear whether that was controlled in the analysis. For the oil price: Did you use monthly or annual oil price in the analysis? If monthly, have you tried using the average oil price over a few months (4-5 months for example)?
5. Are the results and conclusions of the analysis in the draft report presented in appropriate ways? Were the conclusions in the draft report reasonably drawn? Do the conclusions follow logically from the results of the analytic methods and procedures?
Several regulations affect the vehicle cost and operation cost. I found the following conclusion interesting but only for the 2014 regulations. First, Table 3 did not show the expected cost impact of the 2014 regulations. Secondly, again, a brief description of each studied regulation and their impacts on vehicle ownership cost (vehicle, operation, maintenance) would be helpful. Third, did you find similar things for other regulations? Fourth, if this conclusion is true, then the take-way for audiences like DOE would be energy-efficient technologies in HDV could be cost-effective for fleet operators. However, we know, also indicated in this study, that HDV purchases are not fuel cost sensitive. It seems to be this conclusion might be contradictive. Page 62: *This pre-buy effect is short-lived, which is intuitive as the 2014 Phase I regulations increased capital costs, but also offered improved fuel economy, thereby reducing operating costs.*
6. Are the selected figures, tables, and equations well-chosen and constructed to assist the reader in understanding the approach, analytic methods and procedures, results, and conclusions? If yes, explain why. If not, explain how the figures, tables, and equations could be improved to describe the approach, analytic methods and procedures, results, and conclusions more clearly in the report.
Page 44/Figure 8: Could you add an example to show how to read the chart, such as the "regime shifts in the PPI-Trucks corresponding to the 2007 and 2010 enforcement periods"? Figure 18-23: Please add discussions about whether the analysis shows one behavior is greater than the other. For example, does Figure 18 mean there was more "low buy" than "pre buy"? except Figure 18.
7. Are there any other issues or concerns with the validity or scientific/technical merit of this report?
Page 11/17: Why would buyers move up in vehicle class if higher class is more expensive? Then on page 17, it actually states an opposite trend. *"In instances where buyers move up in vehicle class…" (page 11)* *"For example, if the price of class 8 HDVs increases, trucking firms may substitute some class 7 HDVs if they are now relatively less costly to use in providing trucking services." (page 17)* Section 2 Literature Review: Are there any literature on the energy and emissions impact of pre-buy and low-buy behaviors? If yes, could you add a short description of them? Page 24: Did the IEA study which was conducted 13 years later (since 2004) conclude faster decoupling?

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NAME: Dr. Yan (Joann) Zhou
"International Energy Agency (2017) and OECD (2004), for instance, suggest that a decoupling between GDP/economic activity and trucking sector or freight transport activity might be taking place (or has taken place) in the United States, as the U.S. has seen a shift from goods production to services." Figure 4: Font size is too small to see
8. If you are aware of better methods, tools, and available research employed and documented elsewhere to estimate sales, pre-buy, and other such impacts for use in policy analysis, provide suggestions for how they might be used to improve this report and also provide the associated references.
I think the literature review did a good job summarizing the state of the art. I am not aware of other documents, which are not cited here.

5 Peer Reviewers' Curricula Vitae

5.1 Dr. Jose Holguín-Veras

JOSE HOLGUIN-VERAS

6 Christine Ct.
Clifton Park, NY 12065
Email: jhv@rpi.edu

Home phone: 518-348-3845
Work phone: 518-276-6221
Fax: 518-276-4833

1. EDUCATION

- Ph. D., University of Texas at Austin, 1996
- Magister Scientiarum, Universidad Central de Venezuela, 1984
- Civil Engineer, Magna Cum Laude, Universidad Autónoma de Santo Domingo, 1981

Fellowships, awards, and distinctions

- Runner up to the Jack Meredith Best Paper Award from the Journal of Operations Management for the most impactful paper during the 2012-2016 period to the paper "On the unique features of post-disaster humanitarian logistics"
- Finalist of INFORMS' Edelman Award 2017.
- Elected Fellow of the American Society of Civil Engineers, 2014
- Recipient to the 2013 White House Transportation of Change Award.
- Recipient of the 2013 School of Engineering Research Award, Rensselaer Polytechnic Inst.
- Honorary Professor;
  - Daliang Jiaotong University, August 16, 2010
  - Beijing University of Technology (Beijing Overseas Talent Professor), 2016.
  - Universidad del Pacífico, Lima, Perú, August 16th, 2018
  - Universidad Nacional de Colombia, August 24th, 2018
  - Universidad del Valle, April 8th, 2019
- Recipient of the 2007 University Transportation Research Center Best Paper Award for the paper entitled "An Investigation on the Effectiveness of Joint Receiver-Carrier Policies to Increase Truck Traffic in the Off-peak Hours" (Parts I and II), together with Michael Silas, John Polimeni, and Brenda Cruz.
- Recipient of the 2006 Robert E. Kerker Research Award in recognition of Excellence in Research of Special Importance to Practitioners and Scholars of Public Administration and Policy in New York State.
- Recipient of the 2006 School of Engineering Research Award, Rensselaer Polytechnic Inst.
- Recipient of the CAREER Award from the National Science Foundation (2001).
- Recipient of a Proclamation from the City Council of New York honoring his research accomplishments and contributions to local communities (April 17, 2001).
- Recipient of the Milton Pikarsky Memorial Award, 1996 (Council of University Transportation Centers).
- Magna Cum Laude (Civil Engineering), Universidad Autónoma de Santo Domingo, 1981

Fellow of:

- American Society of Civil Engineers, 2014
- State Academy for Public Administration, 2006.
- International Road Federation (IRF), 1991
- Japanese International Cooperation Agency (JICA), 1989
- Organization of American States (OAS), 1982-1984

Editorial Boards, Conference Chairmanship, Leadership Positions

- Founding President of the Pan-American Society of Transportation Research (PANAMSTR), (2018-present)
- Chairman of the Pan-American Advanced Studies Institute on Sustainable Urban Freight Systems, Colombia August 1-14 2014
- President of the Scientific Committee of the Pan-American Conference of Transportation and Traffic Engineering (2010-present)
- Elected Member of the Council of the Association for European Transport (2005-2011)
- Vice President the Scientific Committee of the Pan-American Transportation and Traffic Engineering Conferences (2005-2010)
- Chairman of the XIII Pan American Conference of Traffic and Transportation Engineering, Crowne Plaza Albany, September 27-29 2004
- Chairman of the Pan-American Advanced Studies Institute on Transportation Sciences (PASI-TS), Toluca and Queretaro, Mexico July 24-August 7th 2005
- Member of the Executive Board of the City University of New York's University Transportation Research Center (since 2002).
- Member of the Advisory Board of the University of Vermont's Transportation Center (2006-2010).
- Member of the Conference Program Committee of the National Urban Freight Conference (February 1st-3rd, 2006, Long Beach California)
- Member of the Organizing Committee of the 3rd International Conference on City Logistics (Madeira, Portugal 2003)
- Member of the Organizing Committee of the 4th International Conference on City Logistics (Lankawi, Malaysia 2005)
- Associate Editor of Transportation for Network and Spatial Economics (2003-present)
- Associate Editor of Transportation Research Part A: Policy and Practice (since 2008).
- Chair of the Review Committee (Editor) for the Freight Transportation Planning and Logistics Committee (Transportation Research Board) (2001-2007)

Major public sector (pro-bono) appointments

- USDOT's National Freight Advisory Committee (2012-2016)
- Member of the National Academy of Sciences' Disaster Research Roundtable (2011-2015)
- Member of the Board of the New York State Thruway Authority (2010-2018)
- National Academy of Sciences' Transportation Research Board's Review Committee for the Truck Size and Weight study requested by Congress
- Member of the Federal Emergency Management Agency's Core Group on Community Engagement (June 2011-present)
- Member of the Review Panel for the Cross-Westchester Expressway project (May 2011-2012)
- Member of the Advisory Panel for the NY-NJ-CT-PA Regional Catastrophic Planning Group (March 2010-2012)

2. AREAS OF PROFICIENCY

Humanitarian Logistics

- He is in charge of one of the largest research groups on humanitarian logistics that specializes in the integration of social science and engineering research, and the integration of field work, characterization, and mathematical modeling of the various aspects of the relief efforts. This group has conducted path breaking field research on Katrina, Haiti, Japan, Joplin and many other disasters.

Freight transportation modeling and economics

- Recipient of two national awards: (a) the Milton Pikarsky Memorial Award, from the Council of University Transportation Centers (CUTC) in 1996; and (b) the CAREER Award from the National Science Foundation in 2001, for his contributions to intermodal transportation modeling and transportation economics. Leader in the area of freight behavior, and freight demand modeling.

Transportation Planning/Intelligent Transportation Systems

- Proficient in the use of demand models for policy analysis and transportation system planning. Major role in three national transportation plans and fifteen major urban and regional transportation studies. Highly proficient in the use of advanced modeling techniques, ranging from Random Utility Models, to Land-Use transportation models, and traditional UTPS approaches, including network applications to transportation problems.

Transportation Economics

- Strong background in transportation economics, having performed cutting edge research on road pricing (optimal tolls, behavioral responses from both passengers and freight, development of comprehensive policies), the economic evaluation of more than a thousand hundred transportation projects, including land use projects, transit projects, freeways, two suburban and interstate highways, port projects, rail projects, and rural roads. Has conducted advanced research on price differentiation theory and congestion pricing application to container terminals. Has been consultant for the major international companies and international organizations.

Infrastructure Planning

- Strong background in the areas of: highway design, demand forecasting and economic analysis of urban highways and rural roads. Participated in planning and design of three freeways, two intercity roads, two hundred rural roads, airports, rail and maritime projects in a number of different countries. International consultant in the area of Infrastructure Planning and Modeling. Implemented Pavement Management Systems.

3. EXPERIENCE

Academic

- William H. Hart Professor (July 2010-), Rensselaer Polytechnic Institute
- Professor of Civil and Environmental Engineering (since July 2006), Rensselaer Polytechnic Institute (joint with Decision Sciences and Engineering Systems)
- Associate Professor of Civil and Environmental Engineering (2002-2006), Rensselaer Polytechnic Institute
- Associate Professor of Civil Engineering (2001-2002), The City College of New York.
- Assistant Professor of Civil Engineering (1998-2001), The City College of New York.

- Visiting Assistant Professor of Civil Engineering, The City College of New York (1997).
- Visiting Professor, California Polytechnic State University, San Luis Obispo (1996-1997).
- Adjunct Professor of Transportation Economics and Transportation Planning (1984-1991), and Port Engineering (1989-1991), Universidad Autónoma de Santo Domingo.
- Lecturer of Urban Transportation Planning at the Graduate Course in Transportation Planning, Universidad Autónoma de Santo Domingo 1985-1986.

Leadership

- Director of the VREF Center of Excellence on Sustainable Urban Freight Systems (Since January 2013-current)
- Director of the Center for Infrastructure, Transportation, and the Environment (Since January 2010-current)
- Chair of the Rensselaer Faculty (May 2014 – April 2015)
- President of the Faculty Senate (May 2013 – April 2014)
- Vice-President of the Faculty Senate (February 2012 – April 2013)
- Acting Head, Department of Civil and Environmental Engineering (Jan. 2008-July 2009)
- Deputy Director of the Transportation Planning Directorate, Ministry of Public Works, October 1986-August 1987.
- Academic Coordinator of the Graduate Course in Transportation Planning, Universidad Autónoma de Santo Domingo 1985-1986.
- Head, Transportation Planning Department, Ministry of Public Works, 1984-1986.
- Head of the Special Studies Unit, Ministry of Public Works, Jan. 1981-Aug. 1984.

4. PUBLICATIONS (AN "*" MARKS PAPERS WITH STUDENTS AS LEAD AUTHORS)

Refereed journal publications (published)

1. Holguín-Veras, J., Johanna Amaya Leal, Ivan Sanchez-Diaz, Michael Browne, Jeffrey Wojtowicz, State of the art and practice of urban freight management Part II: Financial approaches, logistics, and demand management, Transportation Research Part A: Policy and Practice, 2018. https://doi.org/10.1016/j.tra.2018.10.036
2. Holguín-Veras, J., Johanna Amaya Leal, Iván Sánchez-Diaz, Michael Browne, Jeffrey Wojtowicz, State of the art and practice of urban freight management: Part I: Infrastructure, vehicle-related, and traffic operations, Transportation Research Part A: Policy and Practice, 2018. https://doi.org/10.1016/j.tra.2018.10.037
3. Cantillo, V., Iván Serrano, Luis F Macea, José Holguín-Veras, Discrete choice approach for assessing deprivation cost in humanitarian relief operations, Socio-Economic Planning Sciences, 63, 33-46, 2018. https://doi.org/10.1016/j.seps.2017.06.004
4. Yushimito, W., José Holguín-Veras, Tomás Gellona, Firm's efficiency and the feasibility of incentives for flextime adoption: a preliminary analysis of Chilean employer's response Transportation Letters, 10(4), 202-214, 2018. https://doi.org/10.1080/19427867.2016.1243297
5. Campbell, S. José Holguín-Veras, Diana G. Ramirez-Rios, Carlos González-Calderón, Lokesh Kalahasthi and Jeffrey Wojtowicz, Freight and service parking needs and the role of demand management, European Transport Research Review, 10(2), 47, 2018. https://doi.org/10.1186/s12544-018-0309-5
6. Gonzalez-Calderon, C., Iván Sánchez-Díaz, Iván Sarmiento-Ordosgoitia, José Holguín-Veras, Characterization and analysis of metropolitan freight patterns in Medellin, Colombia, European Transport Research Review, 10(2), 23, 2018. https://doi.org/10.1186/s12544-018-0290-z

7. Macea, L., Johanna Amaya, Víctor Cantillo, José Holguín-Veras, Evaluating economic impacts of water deprivation in humanitarian relief distribution using stated choice experiments, International Journal of Disaster Risk Reduction, 28, 427-438, 2018. https://doi.org/10.1016/j.ijdrr.2018.03.029
8. Holguín-Veras, J., Trilce Encarnación, Carlos A González-Calderón, James Winebrake, Cara Wang, Sofia Kyle, Nilson Herazo-Padilla, Lokesh Kalahasthi, Wilson Adarme, Víctor Cantillo, Hugo Yoshizaki, Rodrigo Garrido, Direct impacts of off-hour deliveries on urban freight emissions, Transportation Research Part D: Transport and Environment, 61, 84-103, 2018. https://doi.org/10.1016/j.trd.2016.10.013
9. Holguín-Veras, J., Shama Campbell, Carlos A González-Calderón, Diana Ramírez-Ríos, Lokesh Kalahasthi, Felipe Aros-Vera, Michael Browne, Ivan Sanchez-Diaz, Importance and Potential Applications of Freight and Service Activity Models, City Logistics 1: New Opportunities and Challenges, 45-63, 2018. https://doi.org/10.1002/9781119425519.ch3
10. Holguín-Veras, J., Stacey Hodge, Jeffrey Wojtowicz, Caesar Singh, Cara Wang, Miguel Jaller, Felipe Aros-Vera, Kaan Ozbay, Andrew Weeks, Michael Replogle, Charles Ukegbu, Jeff Ban, Matthew Brom, Shama Campbell, Ivan Sanchez-Díaz, Carlos González-Calderón, Alain Kornhauser, Mark Simon, Susan McSherry, Asheque Rahman, Trilce Encarnación, Xia Yang, Diana Ramírez-Ríos, Lokesh Kalahashti, Johanna Amaya, Michael Silas, Brandon Allen, Brenda Cruz, The New York City Off-Hour Deliveries Program: A Business and Community-Friendly Sustainability Program, Interfaces, 48(1), 70-86, 2018. https://doi.org/10.1287/inte.2017.0929
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13. Holguín-Veras, J., Diana Ramirez-Rios, Lokesh Kalahasthi, Shama Campbell, Carlos A Gonzalez-Calderon, Jeffrey Wojtowicz, Quantification of Freight and Service Activity Trends in Cities, Transportation Research Board 97th Annual Meeting Transportation Research Board, 18-06422, 2018.
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Refereed journal publications (in press)

None

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1. Aros, F., Holguín-Veras, J. and J. Mitchell "Optimal Access Restoration for Disaster Relief Logistics" Submitted to the European Journal of Operations Research
2. Amaya, J. Holguín-Veras, J. and J. Mitchell "Optimal Districting Of Disaster Areas", Submitted to the European Journal of Operations Research
3. Jaller, M. and Holguín-Veras, J. "A Disaster Point of Distribution Planning Model Based On Social Costs", Submitted to the European Journal of Operations Research
4. Holguín-Veras, J., T. Encarnación, González-Calderón, C. "User Acceptance of Road Pricing's Core Principles" Submitted to Transportation Research Part A: Policy and Practice
5. Holguín-Veras, J., D.G. Ramírez-Ríos, L.N. Van Wassenhove, V. Cantillo, J. Amaya-Leal, T. Encarnación, "Exploratory Valuation of Anticipation Effects in Post-Disaster Environments" Submitted to the Journal of Operations Management

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1. Ozbay K., O. Yanmaz-Tuzel, and J. Holguin-Veras (2006) " Evaluation of the Combined Impacts of E-ZPass and Time-of-Day Pricing on Port Authority of New York and New Jersey Crossings, Proceedings of ITSC 2006- 9th International IEEE Conference on Intelligent Transportation Systems, Toronto, Canada.
2. Holguín-Veras, J., N. Xu, Q. Wang, K. Ozbay, M. Cetin and J. Polimeni, J.C. Zorrilla and M. Silas "The Behavioral Impacts of the New Jersey Turnpike's Time of Day Pricing Initiative and the Observed Role of Travel Distance on the Underlying Elasticities" Annual Meeting of Transportation Research Board, 2006
3. Holguín-Veras, J., N. Pérez, B. Cruz and J. Polimeni "On the Effectiveness of Financial Incentives to Off Peak Deliveries to Manhattan Restaurants" Annual Meeting of Transportation Research Board, 2006
4. Holguín-Veras, J., Q. Wang, N. Xu, K. Ozbay, M. Cetin and J. Polimeni, and J.C. Zorrilla "Behavioral Impacts of Time Of Day Pricing: General Findings from the Port Authority of New York and New Jersey's Initiative" Annual Meeting of Transportation Research Board, 2006
5. Srinivasan, S., C. R. Bhat, **J. Holguín-Veras** and C. Chen "Impact of Security Perception on Intercity Mode Choice: A Panel Rank-ordered Mixed-Logit Analysis" Annual Meeting of Transportation Research Board, 2006
6. Ozbay, K., O. Yanmaz-Tuzel, and **J. Holguín-Veras** "The Impacts of Time of Day Pricing Initiative at NY/NJ Port Authority Facilities Car and Truck Movements" Annual Meeting of Transportation Research Board, 2006
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25. Seruya, B. and **J. Holguín-Veras** (2004) "The Role of Qualitative Research in Transportation Studies: Experiences from a Case Study" published by the XIII Pan American Conference of Traffic and Transportation Engineering (CD ROM) Albany NY.
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2. Kinney, P., J. Holguín-Veras and M. Carter, "Air Pollution and Traffic at Hunts Point," Research Report published by the University Transportation Research Center, October, 2000.
3. Holguín-Veras, J. and C.M. Walton (1997a) "The Performance Analysis of Priority Systems." Research Report SWUTC/97/467304-1, Center for Transportation Research, The University of Texas at Austin, August 1997, Austin, TX 78712.
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6. Holguín-Veras, J. and C. Walton (1995b) "The Role of Information Technology on the Implementation of Priority Systems and The State of the Practice of Information System and Information Technology on Marine Container Ports." Research Report SWUTC/96/721928-3, Center for Transportation Research, University of Texas at Austin, Austin, TX 78712.
7. Holguín-Veras, J. and C. Walton (1995c) "The Calibration of PRIOR, A Computer System for the Simulation of Port Operations Considering Priorities." Report SWUTC/96/721928-1, Center for Transportation Research, University of Texas at Austin, Oct. 1995, Austin, TX 78712.
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5. CURRENT PROJECTS

- "Collaborative Private-Public Approaches to Foster Energy Efficient Logistics in the Albany-New York City Corridor" ($2,000,000) US Department of Energy (2017-2020). This project seeks to develop behavior-based policy approaches to foster changes in supply chains to reduce fuel consumption.
- "Role of Non-Established Relief Groups (NERGs) after Hurricanes Harvey, Irma, and Maria" ($120,000), National Science Foundation. This project is intended to collect fieldwork data about the performance of Non-Established Relief Groups.

- "Effective Decision-Making Methods for Freight-Efficient Land Use" ($250,000), NCHRP 08-111.This project seeks to develop models and methodologies to foster freight efficient land uses.
- "Methodology Implementation to Assess the Impact of Congestion on Supply Chains in Haiti" ($80,000), Inter-American Development Bank. This project intends to quantify the impacts of congestion on the supply chains in Haiti using GPS data loggers.
- "Freight Demand Model for Bangladesh" ($250,000) Funded by the World Bank, this project seeks the development of data efficient demand models for Bangladesh.
- "Engaging Large Retailers on Off-Hour Delivery Programs" (United States Department of Transportation, $100,000). This is a continuation effort that attempts to enlist the support of nationwide retailers to foster off-hour delivery operations in large cities.
- "Development of a Trusted Vendor Program to Support the Off-Hour Delivery Program" NYSERDA, $300,000
- Volvo Research and Education Foundations' Center of Excellence on Sustainable Urban Freight Systems (COE-SUFS). This five years project is intended to foster an international transformation of urban freight systems (Total budget: $3,800,000)
- NCFRP 44 "Impacts of Policy Induced Modal Shifts" (National Cooperative Freight Research Program, October 1, 2013, December 2014) (Total budget: $350,000) This important project aims at the estimation of freight mode choice models.

6. COMPLETED PROJECTS

- "Remote Sensing Decision Support Tools For Optimal Access Restoration In Post Disaster Environments" This project will develop methodologies to optimally restore access in transportation networks impacted by disasters (United States Department of Transportation, $700,000)
- "Methodology to Assess the Impacts of Congestion on Supply Chains" Inter-American Development Bank ($200,000).
- "NCFRP 25: Freight Trip Generation and Land Use" (National Cooperative Freight Research Program, June 1, 2012, May 30st 2013) (Total budget $400,000 Second phase)
- "Pan-American Advanced Studies Institute on Sustainable Urban Freight Systems" (NSF-OISE-1242113). This project is intended to organize a workshop on Sustainable Urban Freight Systems in Colombia (Total budget $100,000).
- "Cyber Enabled Discovery System for Advanced Multidisciplinary Study of Humanitarian Logistics for Disaster Response" (NSF-IIS 1124827) (Total budget: $1,510,000) This project aims at developing state of the art models to deal with the unique complexities of humanitarian logistics.
- "Integrative Freight Demand Management in the New York City Metropolitan Area: Implementation Phase" (United States Department of Transportation); July, 1 2011-June 30, 2013; Co-PIs: Kaan Ozbay, and Alain Kornhauser; Total budget $3,200,000). This project focuses on implementing off-hour deliveries in the NYC metropolitan area.
- "Field Investigation on Post-Disaster Humanitarian Logistic Practices under Cascading Disasters and a Persistent Threat: The Tohoku Earthquake Disasters" (NSF-RAPID 1138621) (Total budget: $50,000) This project is intended to identify the lessons to be learned from the response to the Tohoku disasters.
- NCFRP 38 "Improving Freight in Metropolitan Areas" (National Cooperative Freight Research Program, June 1, 2012, May 30st 2013) (Total budget: $450,000) This important

project aims at defining techniques and procedures to increase the sustainability of freight activity in urban areas.

- "DRU: Contending with Materiel Convergence: Optimal Control, Coordination, and Delivery of Critical Supplies to the Site of Extreme Events" (National Science Foundation CMMI-0624083); January 2007-December 2010; Co-PIs: Tricia Wachtendorf, Satish Ukkusuri; Total budget=$749,298). This project focuses on the development of new paradigms of supply chain modeling integrating social sciences and logistics.
- "RAPID: Field Investigation on the Comparative Performance of Alternative Humanitarian Logistic Structures" (National Science Foundation NSF-RAPID 1034365); (Total budget: $50,000) January 2011 – December 2012, Co-PI Professor Tricia Wachtendorf. This project gathered field data concerning the performance of the humanitarian logistic systems that emerged after the Haiti earthquake.
- "NCFRP 25: Freight Trip Generation and Land Use" (National Cooperative Freight Research Program, January 1, 2010 March 31st 2011) (Total budget $300,000 First phase)
- "NCFRP 26: Freight Cost Data Elements" (National Cooperative Freight Research Program, July 1, 2010 December 31st 2011) (Total budget $300,000)
- "New York City Park & Ride Study" (New York State Department of Transportation) December 15, 2008-June 14, 2010 (Total budget $256,000)
- "Feasibility Study for Freight Data Collection" New York Metropolitan Transportation Council (May 1, 2009-May 30th 2011) (Total budget $100,000)
- "Integrative Freight Demand Management in the New York City Metropolitan Area" (United States Department of Transportation); July, 1 2007-April 30, 2010; Co-PIs: Satish Ukkusuri, Kaan Ozbay, and Drs. Allison de Cerreño and Alain Kornhauser; Total budget $1,865,136). This project focused on designing and testing an innovative freight demand management for the NYC metropolitan area.
- "A Smarter I-278 Corridor: Moving People, Freight, and the Regional Economy, Phase I" University Transportation Research Center (Total budget $145,000)
- Director of the Center for Intermodal Freight Mobility and Security (jointly with the University of Maryland); 2005-2009 Funded by the Federal Highway Administration (Total budget: $700,000). This project focuses on the development of new modeling paradigms for freight security and mobility analyses.
- "SGER: Characterization of the Supply Chains in the Aftermath of an Extreme Event: The Gulf Coast Experience" (National Science Foundation CMMI-0554949); February 2006-January 2008; Professors Tricia Wachtendorf and Satish Ukkusuri are Co-PIs; Total budget=$90,482). This project gathered perishable data about formal and emergent supply chains after Katrina.
- "Synthesis of Freight Origin-Destination Matrices from Intelligent Transportation Systems Data (CAREER Award, CAREER- 0245165)" (National Science Foundation; March 2001-February 2008; Total budget = $375,000). This project intends to develop techniques to dynamically estimate OD matrices from ITS data for traffic control and planning purposes.
- "Dynamic Game Theoretic Models for Urban Freight Systems" (National Science Foundation CMS-0324380); August 2003-July 2007; Professors Terry Friesz and Warren Powell, Co-PIs; Total budget=$482,611). This project intends to develop a new formulation for urban goods processes based on dynamic game theory.
- "Impacts of Extreme Events: A Systematic Analysis of Individual Travel Choice Decisions" (National Science Foundation; CMS-0301391, May 2003-February 2007; Professors Robert

Paaswell and Chandra Bhat, Co-PIs; Total budget: $249,573). This project assessed changes on passenger travel behavior produced by the 9/11 attack.

- "Potential for Off-Peak Deliveries to Commercial Areas" (New York State Department of Transportation, January 2003-December 2006) (Total budget = $300,000). This project focuses on the definition of policies aimed at increasing off-peak deliveries to commercial areas in New York City.
- "Pan-American Advanced Studies Institute on Transportation Sciences" (National Science Foundation OISE-0418035); August 2004-July 2005; Professor George List is Co-PI; Total budget=$97,060). This project intends to create the foundations for long term collaboration between American and Latin American scientists.
- "Evaluation Study of the Port Authority of New York and New Jersey's Value Pricing Initiative" (Federal Highway Administration Value Pricing Program January 2002 – March 2005; Total budget = $750,000). This project intends to assess behavioral and systemwide impacts of the pricing initiative at the PANYNJ facilities.
- "Evaluation Study of the New Jersey Turnpike Authority's Value Pricing Initiative" (Federal Highway Administration Value Pricing Program; January 2002 – June 2005; Total budget = $450,000). This project intends to assess behavioral and systemwide impacts of the pricing initiative at the NJTA facilities.
- "Impacts of Extreme Events on Passenger Travel Behavior" (Professor R. Paaswell is Co-Principal Investigator) (National Science Foundation; April 1, 2002 – March 31, 2003; Total budget = $50,000). This project assessed changes on passenger travel behavior produced by the 9/11 attack.
- "Integrative Freight Market Simulation" (National Science Foundation, CMS-1079266; September 2000-August 2002; Total budget = $84,500). This project developed a new modeling framework for freight movements on the basis of a market equilibrium formulation.
- "Human Factors in Nighttime Construction Zones" (New Jersey Department of Transportation; October 2000-February 2001; Total budget = $85,000). This project focused on analyzing human factors in nighttime construction zones to define strategies to mitigate the negative impacts upon workers.
- "North East Intermodal Transportation Corridor" (September, 2000- March 2001). This project included freight demand modeling for the New York City metropolitan region (funded by the Port Authority of New York and New Jersey).
- "New Jersey's Links to the 21st Century" (Professor R. Paaswell, Co-Principal Investigator) (New Jersey Department of Transportation; January 2000-December 2002; Total budget = $650,000). This project modeled the relationship between economic development and transportation to help define transportation policy.
- "Strategic Plan for the Development of the Regional Freight Model" (New York Metropolitan Transportation Council; January 2000-May 2001; Total budget = $100,000). This multi-university research project defined a development process for the regional freight model to be developed by NYMTC.
- "Truck-Trip Generation at Marine Container Terminals" (PSC-CUNY; August 1999-July 2001; Total budget = $20,000) As part of this project, conducted in collaboration with the American Association of Port Authorities, data was collected and models of truck-trip generation at container terminals were developed.

- "Operational Evaluation of the Integrated Incident Management System (IIMS)" (New York State Department of Transportation; 2000-2002; Total budget = $110,000). This project conducted a before and after analyses of the impacts of the IIMS on interagency communication.
- "Demand Modeling for the Anillo Metropolitano Project," Guatemala (January-June 1999). This project included the demand modeling and forecast (both freight and passengers) of a major bypass road in Guatemala City.
- "Analysis of the Transportation Alternatives for the Grain Terminal," Dominican Republic, April-July 1991. It included the analysis of the terminal operations, multimodal alternatives, logistics and inventory policy for a new grain terminal.
- "Analysis of the Santo Domingo-San Cristóbal Highway," Dominican Republic, January-May 1989. It included demand forecast, analysis of the alternatives and the economic analysis.
- "National Study of the Service Sector in the Dominican Republic," November 1988-February 1989. Financed by UNCTAD, this project focused on the assessment of the impacts of free market policies upon the transportation system, tourism and export sector. This analysis helped shape the governmental position at the Uruguay Round of GATT.
- "Panama's National Transportation Plan," January-April 1988. It consisted of the calibration of the modal split models, analysis of the intermodal corridors, economic analysis of airport projects (including the Marcos Gelabert airport), pipelines, railroads and port projects (including port simulation), and formulation of the final investment plan.
- "Formulation of the Widening Project of the Simon Bolivar Avenue," Dominican Republic, August-November 1987. It included the design of alternatives, demand forecast and economic analysis.
- "Institutional Development of the Dominican Port Authority," Dominican Republic, September-October 1987. It included demand forecast for the port system and the corresponding simulations, under contract with PRC-Harris. This project was financed by Interamerican Development Bank.
- "Rehabilitation Project of Rural Roads (Loan 98-FIDA-World Bank)," Dominican Republic, August-October 1987. It was comprised of the data collection planning, inspection of 300 km of rural roads, the definition of the alternatives and their economic analysis. This project was financed by the World Bank.
- "Economic Analysis of the Extension of the J.F. Kennedy Avenue," Dominican Republic, May-June 1987. It included the demand forecast and the economic analysis.
- "Ex-post analysis of the Nunez de Caceres Avenue," Dominican Republic, May 1987. It included the demand forecast and the economic analysis.
- "Urban Plan for the Northern Zones of Santo Domingo City," Dominican Republic, March-April 1987. This project considered the settlement of 250,000 people over a five year period. The transportation plan for this urban development was developed.
- "Evaluation of 180 km. of Rural Roads," Dominican Republic, March-April 1987. Under contract with the Interamerican Development Bank, it included the formulation and economic evaluation of the alternatives.
- "Diagnosis and Perspectives of the Arterial System of Santo Domingo City," Dominican Republic, January-February 1987. It was comprised of the comprehensive analysis of the transportation needs and the demand forecast for the network, oriented to the analysis for the project of the fourth bridge over the Ozama river.

- "Transportation Demand Forecast," January-August 1986, Transportation Planning Department, Ministry of Public Works, Dominican Republic. It included the calibration of the demand models and the definition of the alternatives.
- "Pavement Maintenance and Rehabilitation Plan," January-December 1986, Transportation Planning Department, Ministry of Public Works, Dominican Republic. It included the diagnosis of the network, the formulation of alternatives, and the implementation of a Pavement Management System.
- "Definition of the Fiscal Policy for the Transportation Sector," November 1986-May 1987, Transportation Planning Department Ministry of Public Works, Dominican Republic.
- "Analysis of the Railway Project La Vega-Santo Domingo," Dominican Republic, August, 1985. Under contract with DELCANDA Intl. the demand forecast for passengers and freight was done.
- "Definition of the Optimum Policy of Truck Import," Dominican Republic, January 1983-August 1984. It included the definition of the import policy, the forecast of transportation demand and supply, (including the development of fleet deterioration models), and the development of a simulation system for the analysis of the alternatives and the quantification of their impacts.
- "Comprehensive Study of the Transportation System of the Capital Region," Venezuela, June 1983- August 1984. The purpose of this study was the definition of an integrated policy of land use and transportation that contributes to the decentralization of Caracas.
- "Comprehensive Study of the Transportation System of the East Coast of the Maracaibo Lake," Venezuela, February-May, 1983. It included the analysis of different policies of land use and transportation by using transportation and land use integrated models.
- "Institutional Study of the Ministry of Public Works," Dominican Republic, 1982. It encompassed traffic studies, the definition of the optimum axle load for the highway system, and the analysis of the toll system.
- "Planning of the O-D Survey of Santo Domingo City," Dominican Republic, December 1980-April 1981. It included the definition of the statistical frame and planning of the data collection process.
- "Traffic Signal Coordination for the John F. Kennedy and Abraham Lincoln Avenues," Dominican Republic, October-November 1979. It included the design of the system and the economic analysis.

7. SERVICE WORK

At the Rensselaer Polytechnic Institute:

- Chair of the Rensselaer Faculty (May 2014 – April 2015)
- President of the Faculty Senate (May 2013 – April 2014)
- Vice-President of the Faculty Senate (February 2012 – April 2013)
- Co-Chair of the 175th Anniversary Committee (August 2009-2010)
- Member of the Task Force on the Environmental Engineering Program (2009-2010)
- Acting Department Head (December 2007-June 2009)
- Member of the Executive Committee of the Rensselaer's RAMP-UP (Reforming Advancement at Rensselaer) project (December 2007-June 2009)
- Member of the School of Engineering Future of Engineering Committee (2006-2007)
- Member of the Department Head Chair Committee (July 2005-August 2009)

- Member of the Graduate Program Committee at the Civil and Environmental Engineering Department (since July 2002)
- Chairman of the search committee for the geotechnical engineering faculty position (March 2003-March 2004)
- Member of the Space Allocation Committee at the Civil and Environmental Engineering Department (July 2002-2003)

At The City College of New York:

- Member of the CCNY Vice-President for Facilities Search Committee (February 2002)
- Member of the CCNY President's Task Force on Community Outreach (Dec. 2001-July 2002)
- Doctoral Committee (2001- July 2002)
- Member of School of Engineering Dean Search Committee (December 1999-June 2000)
- Curriculum/ABET Committee (1997-2000)

8. STUDENT GUIDANCE

At the Rensselaer Polytechnic Institute:

- Doctoral students: Ellen Thorson (graduated in Spring 2005), Qian Wang (graduated in August 2008), Ning Xu (graduated in August 2008), Michael Silas (graduated in August 2009), Noel Pérez (graduated in 2012), Miguel Jaller (graduated in 2012), Ivan Sanchez (graduated in 2014), Carlos Gonzalez (graduated in 2014), Felipe Aros (graduated in 2014), Johanna Amaya (graduated in 2016).
- Current doctoral students: Shama Campbell, Lokesh Kalahashti, Trilce Encarnacion, Diana Ramirez, and Nilson Herazo
- Master students: Juan C. Zorrilla (graduated in Fall 2004), Shuwen Xia (graduated in Spring 2004), Brenda Cruz (graduated in Spring 2005), Ning Xu (August 2005), Ben Reim (December 2006), Carlos Bastida (August 2007), Pedro Canalda (December 2007), Michael Preziosi (May 2008), Coral Torres (August 2009), Brandon Allen (August 2009), Sofia Kyle (May 2016).
- Advisor to the student chapter of the Society of Hispanic Engineers (SHEP)

At The City College of New York:

- Master students: Mostafa Kamal, Andrew Sakowicz, Abdus Salam, Amr Ibrahim.
- Doctoral students: Judith Peter, Chang Guang, Victor Ochieng

9. COURSE AND CURRICULUM DEVELOPMENT

New courses at Rensselaer Polytechnic Institute:

- CIVL6961: Critical Issues on Transportation

Re-designed courses at Rensselaer Polytechnic Institute:

- CIVL6230: Transportation Economics
- CIVL6260: Transportation Algorithms

New courses at CCNY:

- CE264: Civil Engineering Data Analysis
- CE5741: ITS Fundamentals and Applications
- CE5542: GIS Transportation Modeling

Re-designed courses at CCNY:

- CE5602: Transportation Economics
- CE5635: Traffic Engineering (redesigned as a full multimedia course)

10. PROFESSIONAL ACTIVITIES

Board Member of:

- New York State Thruway Authority (since July 2010)
- Council of the Association for European Transport (Elected Member) (2005-2010)
- Pan-American Transportation and Traffic Engineering Conferences (since 2005)
- Council of Logistics Management's Western New England Roundtable (2004-2009)
- Colegio Dominicano de Ingenieros, Arquitectos y Agrimensores (1985-1986).

Member of award panels for:

- National Science Foundation
- Council of University Transportation Centers (CUTC)

Participation in professional societies and research panels:

- Professional Engineer, New York (since 2000)
- American Society of Civil Engineers (since 1999)
- Member of the International Advisory Committee of the "Brain Korea" (BK) 21 Logistics Team sponsored by the Ministry of Education in Korea at the Pusan National University.
- Member of Transportation Research Board Technical Committees on: Freight Transportation Planning and Marketing (A1B02) (since 1998) and Intermodal Freight Terminal Design and Operations A2M03 (since 1995)
- Member of Transportation Research Board Task Force on Innovations on Freight Transportation Modeling (AT016T) (since November 2003)
- Member of the Council on Transportation (since 1999).
- Member of Colegio Dominicano de Ingenieros, Arquitectos y Agrimensores (Board of Engineers of Dominican Republic) since 1984.

National research panels:

- Member of the United States Department of Transportation's National Freight Advisory Committee, NFAC, (May 2013 – April 2015).
- Member of the National Academy of Sciences' Review Committee of the United States Department of Transportation's Truck Size and Weight Study mandated by the US Congress (July 2013 – December 2013).
- National Cooperative Highway Research Program (NCHRP) Synthesis Panel (2012) 20-05/Topic 44-01: FEMA and FHWA Emergency Relief Funds Reimbursements to DOTs
- Strategic Highway Research Program 2 (SHRP 2) (2012) Capacity Expert Task Group (ETG) for Freight Demand Modeling and Data Innovation Symposium (C43).
- Transportation Research Board (TRB) (2012) "Adapting Freight Models and Traditional Freight Data Programs for Performance Measurement" Chairman of the Pan-American Advanced Studies Institute on Transportation Sciences (PASI-TS), Toluca and Queretaro, Mexico July 24-August 7th 2005

Invited lectures and chairmanships at professional conferences:

- Invited to be the Distinguished Speaker at the David O'Brien Centre for Sustainable Enterprise (DOCSE) on the subject of "Towards Sustainable Urban Freight Systems: The Good, The Bad, and The Ugly" January 23rd, 2014

- Burack Lecturer at the University of Vermont November 14th, 2013 on "The Lessons of Large Disasters for Humanitarian Logistics"
- Commencement speaker at the Instituto Tecnológico de Santo Domingo, Dominican Republic, October 12th, 2013
- Plenary lecturer at the 6th International Conference on Management and Control of Production and Logistics, Fortaleza Brazil on "The Lessons of Large Disasters for Humanitarian Logistics: the Role of Industrial Engineers" September 12th, 2013
- Plenary lecturer at the Sustainable Smart Cities Symposium at the University of Alabama-Birmingham April 3rd, 2013 on "Sustainable and Smart Urban Freight Transport"
- Chairman of the Pan-American Advanced Studies Institute on Transportation Sciences (PASI-TS), Toluca and Queretaro, Mexico July 24-August 7th 2005
- Conference Chairman of the XIII Pan American Conference of Traffic and Transportation Engineering, Crowne Plaza Albany, September 27-29 2004
- Chairman of invited panels on applications of Intelligent Transportation Systems to Commercial Vehicle Operations at the Intelligent Transportation Systems Council (ITSC-IEEE) Conferences (2000, 2001 and 2002).
- Invited as guest speaker at the Rebuild New York Conference, organized by Mr. Alan Hevesi, New York City Comptroller (March 28, 2000).
- Invited by the Government of Singapore to lecture on freight transportation and transportation economics (November 1999).
- Invited to lecture by the Federal Highway Administration on Congestion Pricing and Commercial Vehicle Traffic (January 1999).
- Chairman of the session on Data Envelopment Analysis (DEA) at the Data Connection Conference, New York December 1997.
- Chairman of the session on Strategic Data Sharing Alliances, organized by the Working Group on New York City Area Data, New York Metropolitan Transportation Council (NYMTC) January 1998.

Referee for the following professional journals and professional conferences:

- National Academies' Report on "Measuring International Trade on U.S. Highways" (2004)
- Transportation Research A, B, C, D and E
- Journal of the American Society of Civil Engineers
- Transportation Research Record
- Journal of the Transportation Research Forum
- Decision Support Systems
- World Conferences on Transport Research (since 7th)
- Intelligent Transportation Systems Council (ITSC-IEEE) Conferences (since 2000)

11. PUBLIC OUTREACH ACTIVITIES

- Professor Holguín-Veras is very involved in community activities and in policy making activities that benefit the community at large. He has worked closely with a multitude of community groups and grass root organizations including: The Point Community Development Corporation, Nos Quedamos, Mothers in the Move, The Sports Foundation, New York City Environmental Justice Alliance, and the like.
- Speaker at the Dominican American National Roundtable (Washington, DC) (December 7-10, 2001).

- Liaison with the Association of Dominican Engineers, Society of Hispanic Engineers, Latin-American Students Association.
- Featured in newspapers articles (El Siglo, Manhattan Times, El Diario, New York Post); and TV programs (CBS News channel 47, February 3, 1999).
- Co-organizer of the Award to Meritorious High School Students. This important event, in collaboration with the Dominican Consulate, has taken place at CCNY for the last three years (1999, 2000 and 2001). Awards are given to 300 outstanding High School students of Dominican descent. Fifteen hundred people attend each year the Award Ceremony at the Great Hall of the City College of New York.
- Speaker at the Dominicans 2000 Conference (held at CCNY, February 2000). The main objective of this conference was to outline an agenda for the Dominican community in the U.S. It attracted 1,400 participants.
- Articulated a collaboration agreement between CCNY and the Instituto Tecnológico de Santo Domingo, INTEC (Dominican Republic) for teaching and research on transportation. The agreement was signed by President Y. Moses and President Rafael D. Toribio Domínguez on the 29th of July, 1998.
- Articulated a collaboration agreement between CCNY and the Universidad Central de Venezuela (Venezuela) for teaching and research on transportation.

12. SELECTED INTERVIEWS

- On Sustainable Urban Freight Systems
  - Interview after the David O'Brien Centre Distinguished Speaker Series (January 24, 2014) (https://www.youtube.com/watch?v=QgbQqKwx-SA)
- On Disaster Response Logistics
  - Interview after the meeting of the National Academy of Sciences' Disaster Research Roundtable (March 11, 2011) (https://www.youtube.com/watch?v=0gGxNSqwOX4)

13. LANGUAGES

	Speak	Write	Read
English	Fluently	Fluently	Fluently
Spanish	Fluently	Fluently	Fluently

José Holguín-Veras, Ph.D.,
P.E. William H. Hart
Professor, and
Director of the VREF Center of Excellence for Sustainable Urban Freight Systems

5.2 Dr. Amelia C. Regan

Amelia C. Regan
Professor of Computer Science and
Transportation Systems Engineering
University of California, Irvine, CA

949-228-8626
aregan@uci.edu
http://faculty.sites.uci.edu/aregan/

A. Professional Preparation

- **University of Texas, Austin** 1991-1997
  - PhD in Civil (Transportation Systems) Engineering 1997
  - MSE in Civil (Transportation Systems) Engineering 1995
- **Johns Hopkins University** 1988-1990
  - MS Applied Mathematics 1990
- **University of Pennsylvania** 1983-1987
  - BAS Systems Engineering 1987

B. Experience

- **The University of California, Irvine**
  - Professor of Computer Science, July 2009-Current
  - Professor of Civil Engineering (courtesy), July 2009-Current
  - Founding Director, Master of Computer Science Program 2015-2018
  - Faculty Director, MS and PhD Programs in Transportation Science (Interdisciplinary Program), 2015-2018
  - Associate Professor of Computer Science, July 2003 - June 2009
  - Assistant and Associate Professor of Civil Engineering, March 1997 - June 2009
  - Associate Dean, Bren School of Information and Computer Science, July 2006-June 2009
- **University College London**
  - Reuben Smeed Memorial Professorial Research Fellow, Center for Transport Studies, March 2015-July 2015
- **The Athens University of Economics and Business**
  - Visiting Professor, Decision Sciences Summer 2002, Spring 2003, Spring 2004, Spring 2005, Spring 2006
- **Technical University of Denmark**
  - Visiting Professor, Operations Research Summer, 2003
- **The University of Texas, Department of Civil Engineering**
  - Graduate Research Assistant, September 1991-December 1996
- **United Parcel Service/ROADNET Technologies, Baltimore, MD 1988-1991**
  - Software Engineer/Operations Research Analyst/Industrial Engineering Supervisor
- **Association of American Railroads, Washington, DC 1987 - 1988**
  - Research Analyst

C. Publications

Closely Related

- **Chen, R. and Jin, W. and Regan**, A.C. (2010), Broadcasting Safety Information in Vehicular Networks: Issues and Approaches, *IEEE Network, Special Issue on Advances in Vehicular Communications Networks*
- **Chen, R., D. Ma and A.C. Regan** (2009), TARI: Meeting Delay Requirements in VANETs with Efficient Authentication and Revocation, *International Conference on Wireless Access in Vehicular Environments, WAVE 2009*
- **Wu, D., Lambrinos, L., Przepiorka, T., Arkhipov, D.I., Liu, Q., Regan, A.C. and McCann, J.A.**, 2019. Enabling Efficient Offline Mobile Access to Online Social Media on Urban Underground Metro Systems. *IEEE Transactions on Intelligent Transportation Systems*
- **D. Wu, D.I. Arkhipov, Y. Zhang, C.H. Liu and A.C. Regan** (2015), Online Wardriving by Compressive Sensing. *IEEE Transactions on Mobile Computing* 14(11)
- **Wu, Di, Q. Liu, Y. Zhang, J. McCann, A.C. Regan, N. Venkatasubramanian** (2014), CrowdWiFi: Efficient Crowdsensing of Roadside WiFi Networks, Middleware 2014

Other Recent Publications

- **Asadi, R. and Regan, A.C.**, 2019, A Spatial-Temporal Decomposition Based Deep Neural Network for Time Series Forecasting, *Applied Soft Computing*, in press
- **Asadi, R. and Regan, A.C.**, 2019, A convolution recurrent autoencoder for spatio-temporal missing data imputation,International Conference on Artificial Intelligence, Las Vegas, July
- **Wu, D., Arkhipov, D.I., Kim, M., Talcott, C.L., Regan, A.C., McCann, J.A. and Venkatasubramanian, N.** (2017), ADDSEN: Adaptive Data Processing and Dissemination for Drone Swarms in Urban Sensing. *IEEE Transactions on Computers*
- **D. Wu, D. Arkhipov, J. McCann, A.C Regan** (2017), DeepOpp: Context-aware Mobile Access to Social Media Content on Underground Metro Systems, The 37th IEEE International Conference on Distributed Computing Systems ICDCS 2017
- **R. Asadi, S.S. Kia, A. Regan** (2016), Cycle Basis Distributed ADMM Solution for Optimal Network Flow Problem Over Bi-Connected Graphs 54 Annual Allerton Conference

  Structuring Problem in Combinatorial Auctions for the Procurement of Freight Transportation Contracts,**Transportation Research, Part B:Methodological**, 39 (10)

D.Current Synergistic Activities

- Lead Faculty Recruiter in Computer Science Department for UCI at minority serving conferences, colleges and universities.
- Currently Supervising two African American and two female PhD students in Computer Science
- FIPSE Diverse Educational Community and Doctoral Experience (DECADE) mentor, Computer Science Department, 2012-2018

5.3 Dr. Yìchén (Christy) Zhōu

Updated July 2020

YICHEN CHRISTY ZHOU
Clemson University
John E. Walker Department of Economics
225 Walter T. Cox Blvd, Suite N-320M, Clemson, SC, 29634
Email: yichen2@clemson.edu
Website: http://zhouyc.com

EMPLOYMENT

Assistant Professor of Economics, Department of Economics, Clemson University, July 2016 – Present (On Leave 2016 – 2017)
Postdoctoral Fellow, Resources for the Future (RFF), August 2016 – July 2017

EDUCATION

Ph.D. in Economics, University of Maryland at College Park, May 2016
Dissertation: Essays in Energy, Environment and Technological Change
Committee: Maureen Cropper (Chair), Andrew Sweeting (Co-chair), Lint Barrage, Sébastien Houde
M.A. in Economics, University of Maryland at College Park, May 2014
B.A. in Mathematics and Economics, *Distinction*, University of Virginia, May 2010
B.A. student at large, Huazhong University of Science and Technology, China, 2006 – 2008

FIELDS OF INTEREST

Environmental and Energy Economics, Empirical Industrial Organization

PUBLISHED AND ACCEPTED WORK

"The Effect of Fuel Price Changes on Fleet Demand for New Vehicle Fuel Economy", with Benjamin Leard, Virginia McConnell, *The Journal of Industrial Economics* 67, no. 1, 2019: 127-159

"The Effects of Fuel Prices and Vehicle Sales on Fuel-Saving Technology Adoption in Passenger Vehicles", with Thomas Klier and Joshua Linn, *Journal of Economics & Management Strategy*, 29 (3), 2020: 543-578
(Previously titled: "The Effects of Fuel Costs and Market Size on Fuel-Saving Technology Adoption: Direct and Indirect Effects" and "The Effect of Market Size on Fuel-Saving Technology Adoption in Passenger Vehicles")

WORKING PAPERS

"How Much Do Consumers Value Fuel Economy and Performance? Evidence from Technology Adoption", with Benjamin Leard and Joshua Linn, RFF Report, July 2020, *Third-round Revision Requested, Review of Economics and Statistics*

"Regulatory Spillover and Climate Co-benefits: Evidence from the New Source Review Lawsuits", with Hei-Sing Ron Chan, Janurary 2020, *Under Review*

"Knowledge Capital, Technology Adoption, and Environmental Policies: Evidence from the US Automobile Industry", February 2016

SELECTED WORK IN PROGRESS

"The Effect of Adopting NextGen Air Transportation System on Air Travel Time and Jet Fuel Consumption: Evidence from High-frequency Air Travel Data", with Ziyan Chu, May 2019

"Network Propagation and Air Traffic Policies", with Tom Chungsang Lam, December 2019

TEACHING

Intermediate Microeconomics, Clemson University, Spring 2018 – Present
Introduction to Econometrics, Clemson University, Spring 2018 – Present
Computer Methods in Economics, University of Maryland, Spring 2012 – Spring 2013

GRANTS

Hayek Center for the Business of Prosperity on "Network Propagation and Air Traffic Policies" with Tom Chungsang Lam, Clemson University, 2020, $5,000
NBER Research Grant on "Economics of Energy Use in Transportation", Supported by the Department of Energy, National Science Foundation, and Alfred P. Sloan Foundation, 2018 – 2019, $16,289
Dean's Research Initiative Doctoral Dissertation Research Grant, Behavior and Social Science College, University of Maryland, 2015 – 2016, $2,500

OTHER EMPLOYMENT

Lone Mountain Fellow, Property & Environment Research Center (PERC), Montana, Summer 2016
Summer Intern, Resources for the Future (RFF), Summer 2014, Summer 2015

CONFERENCE AND SEMINAR PRESENTATIONS

(* for Scheduled)
2021: ASSA-TPUG (Chicago)*
2019: NBER Economics of Energy Use in Transportation Conference, AERE (Tahoe), Econometric Society European Meeting, Southeast Energy & Environmental Economics Workshop (GaTech), SEA-Industrial Organization Society
2018: ASSA-AEA (Philly), NBER Energy Use in Transportation Pre-conference, DC IO Day (discussant)
2017: ASSA-AEA (Chicago), American University School of International Service, RFF, IIOC (Boston)
2016: Ohio University, Clemson University, Arizona State University, University of Maryland Baltimore County, IIOC (Philly), PERC
2015: Maryland AREC, Maryland Econ, Northeast Workshop on Energy Policy & Environmental Economics (Yale), Georgetown GCER, Camp Resources

REFEREE AND OTHER SERVICE

Peer-reviewed Journals: Journal of Industrial Economics, Journal of the Association of Environmental and Resource Economists, Journal of Environmental Economics and Management, Energy Journal, Energy Economics, Resource and Energy Economics
Ad Hoc Program Selection: SEA-AERE sessions, 2020
Ad Hoc Grant Proposal Reviews: Alfred P. Sloan Foundation

DEPARTMENT AND UNIVERSITY SERVICE

Task Force for the Tenure, Promotion and Reappointment Committee, 2017 – 2018

5.4 Dr. Yan (Joann) Zhou

Curriculum Vita Yan (Joann) Zhou September 2020

Yan (Joann) Zhou

9700 S Cass Ave, Bldg 362, E337
Lemont, IL 60439

Email: yzhou@anl.gov
Phone: 630-252-1215

EDUCATION

- **Ph.D. in Civil Engineering (Transportation)** 2010
  Clemson University, Clemson, SC
- **M.S. in Civil Engineering** 2008
  Clemson University, Clemson, SC
- **B.S. in Automotive Engineering** 2003
  Wuhan University of Technology, Wuhan, P. R. China

WORKING EXPERIENCE

- **Group Leader, Mobility and Deployment**
  Argonne National Laboratory, Argonne, IL May, 2019 – Present
- **Principal Transportation Systems Analyst**
  Argonne National Laboratory, Argonne, IL Mar, 2012 – Present
- **Operations Manager,**
  U.S.-China Clean Energy Research Center-Clean Vehicle Consortium and TRUCK, Jan., 2016-Present
- **Postdoctoral Researcher**
  Argonne National Laboratory, Argonne, IL May, 2010 – Mar., 2012

AWARDS

- **Launchpad Program, Cohort 3**
  Argonne National Laboratory, Argonne, IL 2018-2019

SELECTED PUBLICATIONS

Technical Reports

Y. Zhou, M., Marianne, T. Stephens, S. Aeschliman, C. Macal (2020) Electric Vehicle Adoption in Illinois, ANL/ESD-20/38. September. Available on-line soon.

D. Gohlke, **Y. Zhou** (2020) Impacts of Electrification of Light-Duty Vehicles in the United States, 2010 – 2019, ANL/ESD-20/4. June. https://www.osti.gov/servlets/purl/1642114.

D. Gohlke, **Y. Zhou** (2019) Impacts of Electrification of Light-Duty Vehicles in the United States, 2010 – 2018, ANL/ESD-19/2. January. https://www.osti.gov/servlets/purl/1506474

M., Marianne, C. Macal, Z. Guo, C. Kaligotla and **Y. Zhou** (2019) Agent-Based Transportation Energy Analysis Model: Methodology and Initial Results. ANL/ESD-19/7, January. https://www.osti.gov/servlets/purl/1618117.

Lu, Zifeng, **Yan Zhou**, Hao Cai, Michael Wang, Xin He, and Steven Przesmitzki (2018) China Vehicle Fleet Model: Estimation of Vehicle Stocks, Usage, Emissions, and Energy Use -Model Description, Technical Documentation, and User Guide. Argonne National Laboratory, ANL/ESD-18/15, October.

T. Stephens, **Y. Zhou**, A. Burnham, and M. Wang (2018) Incentivizing Adoption of Plug-in Electric Vehicles: A Review of Global Policies and Markets, ANL/ESD-18/7. August. https://www.osti.gov/servlets/purl/1480507.

A. Burnham, A. Vyas, **Y. Zhou** and M. Wang (2018) Assessment of Expanding Natural Gas Use in Transportation, ANL/ESD-18/11, May, https://www.osti.gov/servlets/purl/1463249.

Page 1 of 4

Y. Zhou (2018) Non-Light-Duty Energy And Greenhouse Gas Emissions Accounting Tool (NEAT): Documentation And User Guide For Updated Domestic Freight Component, ANL/ESD-18/5, May. https://www.osti.gov/servlets/purl/1433493.

Y. Zhou, Vyas, A, Guo, Z. (2017) An Evaluation of the Potential for Shifting of Freight from Truck to Rail and Its Impacts on Energy Use and GHG Emissions, ANL/ESD-17/12. Report prepared for DOE Vehicle Technologies Office.

Y. Zhou, Levin, T., and Plotkin, S. (2016) Plug-in Electric Vehicle Policy Effectiveness: Literature Review, ANL/ESD/16-8, Report prepared for DOE Office of Energy Policy and Systems Analysis, April.

Y. Zhou, et. al. (2017) Electricity end uses, energy efficiency, and distributed energy resources baseline, Lawrence Berkeley National Laboratory, LBNL-1006983, January, https://emp.lbl.gov/publications/electricity-end-uses-energy.

Y. Zhou, Vyas, A. (2014) VISION Model Description and User's Guide: Model Used to Estimate the Impacts of Highway Vehicle Technologies and Fuels on Energy Use and Carbon Emissions to 2100, ANL/ESD/14-1, http://www.transportation.anl.gov/pdfs/TA/954.PDF

Journal Articles

Bi, Z., **Zhou Y.**, Xie, F., Lin Z., Wood E., Lee, D-Y (2020) Quantification of National Energy Impacts of Electrified Shared Mobility with Infrastructure Support, submitted to *Journal of Energy Policy*.

Hao, X, **Zhou, Y.**, Wang, H, Ouyang M. (2020) Plug-in electric vehicles in China and the USA: a technology and market comparison, *Mitigation and Adaptation Strategies for Global Change* https://doi.org/10.1007/s11027-019-09907-z

Zheng, J., Sun, X, and **Zhou, Y.** (2020) Electric Passenger Vehicles Sales and in China's Leading Market. *Journal of Cleaner Production*, Volume 243, 10 January, 118607.

Bi, Zicheng, Michael Reiner, Gregory Keoleian, **Zhou, Y.**, Michael Wang, and Zhenhong Lin. (2019) "Wireless charging and shared autonomous battery electric vehicles (W+SABEV): synergies that accelerate sustainable mobility and greenhouse gas emission reduction." *Mitigation and Adaptation Strategies for Global Change*, https://doi.org/10.1007/s11027-019-09870-9.

Guo, Z., Zhou, Z., and **Zhou, Y.** (2019) Impacts of Integrating Topology Reconfiguration and Vehicle-to-Grid Technologies on Distribution System Operation. IEEE Transactions on Sustainable Energy, May.

Zheng, J., **Zhou, Y.**, Yu, R., Zhao, D., Lu, Z., and Zhang, P., (2019) Survival rate of China Passenger Vehicles: A Data-driven Approach, Journal of Energy Policy, Volume 129, Pages 587-597.

Guo, Z. and **Zhou, Y.** (2019) Residual Value Analysis Of Plug-In Vehicles In The U.S., *Journal of Energy Policy*. Volume 125, February, Pages 445-455.

Huang, Y., **Zhou, Y.** (2015) An Optimization Framework for Workplace Charging Strategies, *Transportation Research Part C*, pp. 144-155 DOI: 10.1016/j.trc.2015.01.022.

Zhou, Y., Wang, M., Johnson, L., Wang, H., and Hao, H. (2015) Plug-in Electric Vehicle Market Penetration and Incentives: A Global Review, *Mitigation and Adaptation Strategies for Global Change*, Volume 20, Issue 5, pp 777-795.

Hao, H., Wang M., **Zhou, Y.**, Wang H., Ouyang M., (2013) The Levelized Costs of Conventional and Battery Electric Vehicles in China: Beijing experiences, *Mitigation & Adaptation Strategy for Global Change*, DOI: 10.1007/s11027-013-9536-1, published online: 28 December 2013.

Santini, D., **Zhou, Y.**, Kim, N., Gallagher, K., and Vyas, A. (2013) Plug-In Electric Cars for Work Travel Evaluation of Four Electric Powertrains, *Transportation Research Record*, 2385, pp. 53-60.

Zhou, Y., Vyas, A., and Santini, D. (2013) Tracking National Household Vehicle Usage by Type, Age, and Area in Support of Market Assessments for Plug-In Hybrid Electric Vehicles. *Journal of Transportation Technologies*, 3, 174-183.

Elgowainy, A., **Zhou, Y.**, Vyas, A, Mahalik, M., Santini, D., Wang, M. (2012) Impact of Plug-in Hybrid Electric Vehicle Charging Choices in 2030, *Transportation Research Record: Journal of Transportation Research Board, 2287*, pp. 9-17.

Peer-Reviewed Papers in Conference Proceedings

Bi, Z., **Zhou Y.**, Xie, F., Lin Z., Wood E., Lee, D-Y (2020) Quantification of National Energy Impacts of Electrified Shared Mobility with Infrastructure Support, *Proceedings of* 99th Transportation Research Board Annual Meeting, Washington, DC U.S., January 5- 8.

Guo, Z., Huang, J., **Zhou Y.**, and Macal, Y. (2020) Agent-Based Modeling For Electrified Ride-Sourcing Services, *Proceedings of* 99th Transportation Research Board Annual Meeting, Washington, DC U.S., January 5- 8.

Y. Zhou and M. Rood (2019) National Energy Impacts of Heavy Electric Truck Adoption for Freight, EVS32 Symposium, Lyon, France, May 19-22.

Xie F., Z. Lin,, **Y. Zhou**, E. Wood (2018) Will Advanced Public Charging Infrastructure Speed Up Electrification of Future Transportation? 21st IEEE International Conference on Intelligent Transportation Systems, November.

Guo, Z., S. Lei, Y. Wang, Z. Zhou, **Y. Zhou** (2018) Dynamic Distribution Network Reconfiguration Considering Travel Behaviors and Battery Degradation of Electric Vehicles, proceedings of 2017 Power and Energy Society General Meeting, July 16-20.

Z. Guo, R. Campbell, **Y. Zhou** (2018) Residual Value Analysis Of Plug-In Vehicles In The U.S., *Proceedings of* 97th Transportation Research Board Annual Meeting, Washington, DC US, January 7- 11.

Campbell, R., **Y. Zhou,** Z. Lin, and J. Ward (2017) Analysis of Manufacturer Plug-In Electric Vehicle Incentives, *Proceedings of* 96th Transportation Research Board Annual Meeting, Washington D.C.

Zhou, Y., D. Santini and T. Stephens (2016) Comparison of Value Retention of Plug-in Vehicles and Conventional Vehicles and Potential Contributing Factors for presentation, *Proceedings of* 29th Electric Vehicle Symposium, Montreal, Canada, Jun. 19-22.

Zhou, Y., D. Santini, M. Rood, L. Bluestein, G. Mitchell, T. Stephens and J. Ward (2016) An Assessment of Causes of PEV Success across U.S. Metro Areas, *Proceedings of* 29th Electric Vehicle Symposium, Montreal, Canada, Jun. 19-22.

Santini, D., **Y. Zhou,** G. Mitchell, T. Stephens and J. Ward (2016) Plug-in Vehicle Attributes' Influence on U.S. Sales in 2014 in States without Preferential Incentives for ZEVs, *Proceedings of* 29th Electric Vehicle Symposium, Montreal, Canada, Jun. 19-22.

Rood, M., D. Santini, **Y. Zhou,** G. Mitchell, T. Stephens, J. Miller and L. Bluestein (2016) Implications of Successes and Failures of BEV-Focused Incentive Support for PEVs in the U.S. and EU, *Proceedings of* 29th Electric Vehicle Symposium, Montreal, Canada, Jun. 19-22.

Zhou, Y., Santini, D., Stephens, T., Ward, J. (2016) Comparison of Value Retention of Plug-in Vehicles and Conventional Vehicles and Potential Contributing Factors, *Proceedings of 95th Transportation Research Board Annual Meeting*, Washington, DC, USA, Jan. 11-15.

Santini, D., **Zhou, Y.** (2015) Potential to Electrify Miles with Different Plug-in Vehicle Innovation Paths, *Proceedings of 94th Transportation Research Board Annual Meeting*, Washington, DC, USA, Jan. 11-15.

Santini, D., **Zhou, Y.**, V. V. Elango, Y. Xu, and R. Guensler (2014). Daytime Charging – What is the Hierarchy of Opportunities and Customer Needs? — A Case Study Based on Atlanta Commute Data, *Proceedings of 93rd Transportation Research Board Annual Meeting*, Washington, DC, USA, Jan. 12-16.

Santini, D., **Zhou, Y.**, Stephens, T., Vyas, A. (2013) Cost Effective Annual Use and Charging Frequency for Four Different Plug-in Powertrains," SAE Technical Paper 2013-01-0494, 2013, doi:10.4271/2013-01-0494, presented in the SAE 2013 World Congress & Exhibition, Detroit, Michigan, USA, Apr. 16-18.

Santini, D., **Zhou, Y.**, Kim. N., Gallagher, K., and Vyas, A. (2013) Deploying Plug-in Electric Cars Which are Used for Work: Compatibility of Varying Daily Patterns of Use with Four Electric Powertrain Architectures," *Proceedings of 92nd Transportation Research Board Annual Meeting*, Washington, DC, USA, Jan. 13-17.

Stephens, T., **Zhou, Y.**, Elgowainy, A., Duoba, M., Vyas, A., Rousseau, A., (2013) Estimating On-Road Fuel Economy of PHEVs from Test and Aggregated Data, *Proceedings of 92nd Transportation Research Board Annual Meeting*, Washington, DC, USA, Jan. 13-17.

Zhou, Y., Vyas, A., Elgowainy, A., Santini, D., (2012) Impacts of Multiple Daily PHEV Charging on Electrified Miles and Energy Demand, to be published in *Proceedings of EVS 26th International Electric Vehicles Symposium*; Los Angeles, CA, May 6-9.

Santini, D., **Zhou, Y.**, Vyas, A. (2012) An Analysis of Car and SUV Daytime Parking for Potential Opportunity Charging of Plug-in Electric Powertrains – Effects on Hourly Electricity Demand and Total Petroleum Use Reduction, to be published in *Proceedings of EVS 26th International Electric Vehicles Symposium*; Los Angeles, CA, May 6-9.

Zhou, Y., Vyas, A., Santini, D. (2012) Tracking National Household Vehicle Usage by Type, Age, and Area in Support of Market Assessments for Plug-in Hybrid Electric Vehicles, *Proceedings of 91th Transportation Research Board Annual Meeting*, Washington. D.C., Jan. 22-26.

Elgowainy, A., **Zhou, Y.**, Vyas, A, Mahalik, M., Santini, D., Wang, M. (2012) Impact of Plug-in Hybrid Electric Vehicle Charging Choices in 2030, *Proceedings of 91th Transportation Research Board Annual Meeting*, Washington. D.C., Jan. 22-26.

6 Agenda for Peer Review Teleconference

This section presents the 2-page agenda for the November 4, 2020, peer review teleconference.

AGENDA

November 4, 2020 Peer Review Teleconference

Analysis of Heavy-Duty Vehicle Sales Impacts due to New Regulation

12:00-12:10pm (10 mins)	**Welcome and Introductions; Review of Agenda/Process for Peer Review Teleconference:** Amy Doll, EnDyna, Peer Review Lead; Kirsten Franzen, RTI International, RTI Project Manager
12:10-12:15pm (5 mins)	**Background on Draft Report:** Gloria Hefland, EPA/OTAQ Brief overview of *Project History and Objectives* section of Peer Review Materials Package
12:15-12:20pm (5 mins)	**Scope of Peer Review:** Amy Doll, EnDyna, Peer Review Lead Review of *Charge for the Scope of this Peer Review* section of Peer Review Materials Package
12:20-12:35pm (15 mins)	**Clarification questions related to Charge Questions #2, #3, and #5:** Kirsten Franzen/Amy Doll 1) Provide clarification about analytical assumptions for how the potential regulation would affect actual purchases. The authors review the industry background but could do it in a way that is directly related to the identification in Eq(4). For each round of the regulation, the mandate is effective on specific model years (MY) and onward. (I understand the authors state model year may not be relevant since the way the business works is through bargaining for a fleet of vehicles and through doing made-to-order.) As example scenario, if a 2007 regulation will affect all new trucks in MY 2007, at the end of 2006 or in early months of 2007, can a buyer specify an order of an older model to get away from the regulation? This will create wiggle room for a buyer to make a purchase that is in the short run exempted from the regulation. This is important because readers need to know exactly what beta4 and beta5 are identified from. This scenario I suspect does not mean the identification in Eq(4) is invalid, but if that scenario is possible and if buyers do that a lot, the effect of pre-buy and low-buy can be even higher (aka authors find a lower bound).
12:35-12:50pm (15 mins)	**Clarification questions related to Charge Questions #2, #3, and #5:** Kirsten Franzen/Amy Doll 2) Have the authors considered about how manufacturers can manipulate the price? HDV is not concentrated as the LDV market, so I am fine with the price-taker assumption. But since there is a bargaining process, it is important that analyses are not picking up effects of lower prices in December and higher prices in months after the regulation during the bargaining process.
12:50-1:05pm (15 mins)	**Clarification questions regarding Charge Question #4 on technical methods:** Kirsten Franzen/Amy Doll 3) Why do the authors change how they describe their model: in the introduction, the authors say they use time-series methods, then in the main analysis, the authors say they use difference-in-differences. Then when the authors show the equation and the results, it appears the authors use an event-study model. I am not able to comment on this charge question since I am not sure whether authors are doing (i) event-study without a control group, or (ii) event-study with a control group by using no-regulation-change years as a control, the latter of which is essentially a diff-in-diff in the event study-format. I think the confusion arises from (a) unclear subscripts in Eq(4), (b) notation of the month variable (it is unclear whether the month variable refers to the month in the dataset or if the authors mean the month-of-year), and (c) a lack of discussion of identification after Eq(4), all of which could be easily explained.
1:05-1:20pm (15 mins)	**Clarification questions regarding Charge Question #4 on technical methods:** Kirsten Franzen/Amy Doll 4) Can the authors or EPA clarify whether the Agency requires this analysis to extrapolate the results to implications on elasticities? Changes in price are associated with changes in sales for factors correlated to both. In addition to the common endogeneity issue, the price measure is a sales-weighted-price so it has a limitation in what this variable measures.
1:20-1:45pm (25 mins)	**Additional Clarification Questions (if any):** Kirsten Franzen/Amy Doll Any such scientific/technical questions should be related to improving a reviewer's ability to respond effectively to a specific Charge Question, and must be within the Charge for the Scope of this Peer Review.
1:45pm	**Adjourn:** Amy Doll, EnDyna, Peer Review Lead

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Peer Review Teleconference "Ground Rules"

- An external peer review is intended to solicit individual reviewer feedback, to increase the independence of the peer review process.
- The peer reviewers are not asked to, and should not attempt to, form consensus or collective recommendations, ratings, or opinions, and peer reviewers must understand that they should provide individual feedback on the research product.
- Any EPA staff that may attend the peer review teleconference can only provide background information on the research product to the peer reviewers, which can occur only during the teleconference run by EnDyna, and at EnDyna's request.
- The peer review teleconference will not include discussion related to EPA's policies and decisions or current or proposed EPA regulations.

EPA Charge for the Scope of this Peer Review
EPA has defined the scope of this peer review for the ERG draft report in order to focus the peer review process effectively on EPA's Charge Questions. Your written comments should stay within the EPA scope defined below.

The scope of this letter-style peer review is technical in nature, reviewing the methods, data quality, data sources, underlying assumptions, and the overall strengths and limitations of the study. EPA is especially interested in comments that focus on the validity or scientific merit of the methodology and that identify any significant weaknesses in the scientific information from the methodology.

- **Peer reviewers should focus on providing comments on the technical nature of the report, and its consistency with the state of current science as you understand it. The peer reviewers should evaluate the analysis used to develop the proposed methods and the suitability of those methods to estimate sales, pre-buy, and other impacts for use in policy analysis.**
- **Peer reviewers should also focus on the clarity and completeness of the presentation in the draft report. Because the review is technical in nature, the peer reviewers should not focus on editorial style.**

Work Scope and Schedule
Your function as a peer reviewer is to review and provide written comments on the ERG draft report. Specifically, you shall evaluate the ERG draft report, respond to EPA's Charge Questions provided [in Charge Document, included within Peer Review Materials Package], and provide specific comments that you feel could improve the quality of the report. You are not requested to and should not provide input or advice on EPA's policies, regulations, or policy/regulatory decisions. Your review is not page-limited, and you should take as much space as you feel is necessary to complete your written responses to EPA's Charge Questions.

KEY PEER REVIEW DATES	
Receive Peer Review Materials Package	October 13, 2020
Attend and Participate in Peer Review Teleconference	November 4, 2020
Complete and Submit Final Written Comments	November 20, 2020

7 Conflict of Interest Form and Non-disclosure / Confidentiality Agreement

U.S. Environmental Protection Agency
Conflict of Interest Inquiry

You are being considered to serve as a Peer Reviewer for an EPA report tentatively entitled, *Analysis of Heavy-Duty Vehicle Sales Impacts Due to New Regulation*, and your involvement in certain activities could pose a conflict of interest or create the appearance of a loss of impartiality in your review. Although your involvement in these activities is not necessarily grounds for exclusion from the peer review, affiliations or activities that could potentially lead to conflicts of interest are included in the table.

Please complete the table and sign the certification below. If you have any questions, contact the Peer Review Lead, Amy Doll, at EnDyna, Inc. (adoll@endyna.com) at your earliest convenience to discuss any perceived conflict of interest issues. Please refer to the section below: "Information Relating to Conflict of Interest."

Conflict of Interest Analysis	YES	NO
1. To the best of your knowledge and belief, is there any connection between the subject chemical or topic and any of your and/or your spouse's compensated or uncompensated employment, including government service, during the past 24 months?		
2. To the best of your knowledge and belief, is there any connection between the subject chemical or topic and any of your and/or your spouse's research support and project funding, including from any government source, during the past 24 months?		
3. To the best of your knowledge and belief, is there any connection between the subject chemical or topic and any consulting by you and/or your spouse, during the past 24 months?		
4. To the best of your knowledge and belief, is there any connection between the subject chemical or topic and any expert witness activity by you and/or your spouse, during the past 24 months?		
5. To the best of your knowledge and belief, have you, your spouse, or dependent child, held in the past 24 months, any financial holdings (excluding well-diversified mutual funds and holdings, with a value less than $15,000) with any connection to the subject chemical or topic?		
6. Have you made any public statements or taken positions on or closely related to the subject chemical or topic under review?		
7. Have you had previous involvement with the development of the document (or review materials) you have been asked to review?		
8. To the best of your knowledge and belief, is there any other information that might reasonably raise a question about an actual or potential personal conflict of interest or bias?		
9. To the best of your knowledge and belief, is there any financial benefit that might be gained by you or your spouse as a result of the outcome of this review?		
10. Compensated and non-compensated employment (for panel member/peer reviewer and spouse): list sources of compensated and uncompensated employment, including government service, for the preceding two years, including a brief description of the work.		

1 of 4

11. Research Funding (for panel member/peer reviewer): list sources of research support and project funding, including from any government, for the preceding two years for which the panel member/peer reviewer served as the Principal Investigator, Significant Collaborator, Project Manager or Director. For the panel member/peer reviewer's spouse, provide a general description of the spouse's research and project activities for the preceding two years.
12. Consulting (for panel member/peer reviewer): list all compensated consulting activities during the preceding two (2) years, including the names of the clients if compensation provided 15% or more of your annual compensation. For the panel member/peer reviewer's spouse, provide a general description of the spouse's consulting activities for the preceding two years.
13. Expert witness activities (for panel member/peer reviewer): list the sources of compensated expert witness activities and a brief description of each issue and your testimony. For the panel member/peer reviewer's spouse, provide a general description of the spouse's expert testimony provided in the preceding two years.
14. Assets: Stocks, Bonds, Real Estate, Business, Patents, Trademarks, and Royalties (for panel member/peer reviewer, spouse, and dependent children): list specific financial holdings that collectively had a fair market value greater than $15,000 at any time during the preceding 24-month period (excluding well-diversified mutual funds, money market funds, treasury bonds and personal residence).
15. Liabilities (for panel member/peer reviewer, spouse, and dependent children): list liabilities over $10,000 owed at any time in the preceding twelve months (excluding a mortgage on your personal residence, home equity loans, automobile and consumer loans).

16. Public Statements: Provide a brief description of any public statement and/or positions taken that are closely related to the matter under review by the panel member/peer reviewer.
17. Involvement with document under review: Provide a brief description of any previous involvement of the panel member/peer reviewer in the development of the document (or review materials) the individual has been asked to review.
18. Other potentially relevant information: Provide a brief description of any other information that might reasonably raise a question about actual or potential personal conflict of interest or bias.

CERTIFICATION

I hereby certify that I have read the above statements and, to the best of my knowledge and belief, no conflict of interest exists that may diminish my capacity to provide an impartial, technically sound, objective review of the subject matter or otherwise result in a biased opinion.

Name - please print: _____

Signature: _____

Date: _____

Information Relating to Conflict of Interest (COI)

Peer reviewers are expected to provide an impartial, technically sound, objective, independent, and unbiased technical review of the study entitled:

Analysis of Heavy-Duty Vehicle Sales Impacts Due to New Regulation.

We request the information in this COI Inquiry from interested peer reviewer candidates for the purpose of ruling out COI and other concerns as we work to create an independent and balanced selection of peer reviewers. An interested peer reviewer candidate's involvement in certain activities could pose a COI or create the appearance of a loss of impartiality in the peer review. Although involvement in such activities is not necessarily grounds for exclusion from the peer review, peer reviewer candidates need to disclose affiliations, interests, activities, or relationships that could lead to perceived COIs.

Before you can be selected and agree to serve as a peer reviewer, you will need to disclose any Actual or Potential COI (as explained below) on this form. The financial and professional information obtained from the interested peer reviewer candidate as part of the evaluation to determine the existence of an Actual or Potential COI is considered private and non-disclosable to outside entities except as required by law and/or regulation.

The following definitions provide general descriptions of Actual or Potential COI:

- **Actual COI:** An Actual COI would be any financial interest held by an individual (or certain related persons) that could be affected by their participation in the peer review.
- **Potential COI:** A Potential COI could be any circumstance related to an individual (or certain related persons) that may cause "a reasonable person with knowledge of the relevant facts" to question the individual's impartiality in participating in the peer review (i.e., "an appearance of loss of impartiality").

To preserve the independence and ethics of the peer review process, individuals with Actual or Potential COIs may not be allowed to participate in the peer review. Please consider carefully whether you might have an Actual or Potential COI or if any other interests, activities, or relationships would cause your impartiality as a peer reviewer to be questioned.

If you have any questions, contact the EnDyna Peer Review Lead, Amy Doll (adoll@endyna.com) at your earliest convenience to discuss any perceived COI issues.

For more information about peer reviews, see the EPA Peer Review Handbook, 4th Edition, October 2015.

Non-Disclosure / Confidentiality Agreement

Peer reviewers are to provide written comments responsive to the charge questions in a specified format by a specified deadline. I agree to use the information revealed during peer review of the:

EPA draft report tentatively entitled, *Analysis of Heavy-Duty Vehicle Sales Impacts Due to New Regulation*

only for U.S. Environmental Protection Agency (EPA) peer review purposes and understand that I must treat all of the information as confidential and proprietary.

I also agree to treat all of the supplementary information as confidential and proprietary, if any such supplementary background materials are provided for this peer review.

- Peer reviewers must comply with requests for confidentiality, as stated above, regarding the release of draft Agency products, positions or other materials provided to the reviewer. All reports, spreadsheets, and any other background materials provided as part of the review should be kept confidential and should not be discussed or shared with anyone, except the EnDyna Peer Review Lead: Ms. Amy Doll (or RTI Peer Review Lead: Ms. Kirsten Franzen).
- Peer reviewers must avoid interactions—including with Agency representatives or members of the interested public—that might create a perception of conflict of interest regarding the work product under review. Exercise due care to avoid any actual or perceived conflict of interest in carrying out this peer review.
- Peer reviewers should immediately inform the EnDyna (or RTI) Peer Review Lead if they are contacted regarding this peer review or work product by anyone else. EnDyna will immediately inform EPA of any such reports by peer reviewers to guard against inappropriate influence from outside the selected peer reviewers.
- Peer reviewers will advise the EnDyna (or RTI) Peer Review Lead of the disclosure of any information related to this peer review that is disclosed, used, or handled in a manner inconsistent with this agreement.

If in the course of this peer review, I do acquire or have access to any information, data, or material which is confidential, proprietary, or otherwise privileged, and is so indicated in writing, I agree that such information will not be divulged to any person or any organization or utilized for my own private purposes or in any manner whatsoever, other than in the performance of this peer review:

1. without the prior written permission of EnDyna (or RTI) Peer Review Lead for the work being evaluated, or
2. until such information, data, or material is first publicly disseminated by the EPA or its contractor or grantee performing the work, or
3. is or becomes known to the public from a source other than me, or
4. is already known to me or my employer as shown by prior records, whichever event shall first occur, and this knowledge was already disclosed in my signed Conflict of Interest (COI) form.

After this peer review, I will destroy and/or delete all reports, spreadsheets, and any other background materials related to this peer review.

_____ _____

(Signature) (Date)

_____

(Name)
Printed or Typed